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Brazil's HIV/ AIDS Model: Is It Working Fortaleza? - Spatial Analysis of HIV/ AIDS

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Brazil's HIV/ AIDS Model: Is It Working Fortaleza? - Spatial Analysis of HIV/ AIDS

by

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Thesis

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Dedication

I dedicate this work to all of the individuals who survive the daily struggle of living with HIV or AIDS, and who overcome the painful reality of stigma and discrimination.

This work would not have been made possible if not for the incredible support of my family and friends. Especially my partner in crime: María José LaRota. This work encompasses our many sleepless nights, endless cups of coffee and stressful tears. You will forever be in the memories of these years and without you, graduate school would have not been nearly as enjoyable.

To my gorgeous nephews, Lukas Porto and Matheus Logan Porto, who provide me with the most pure love and much needed moments of laughter and joy amidst the stress of graduate school.

Anne Simoni, who I love dearly, stood by me during this process, was my rock, and never failed to provide loving words of encouragement when I most needed them; I dedicate this to you. I love you!

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And lastly, I dedicate this to my mother, Sandra Cidrão Alexandrino, who taught me to be strong, believe, and persevere through life's ups and downs. Through her actions, she instilled in me dignity and the gift of compassion. More importantly, she taught me to speak for those who do not have a voice.

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The University of Texas at Austin, 2012

Supervisor: Jennifer A. Miller

The prevalence rate of the Human Immunodeficiency Virus (HIV) in Brazil has stabilized since the year 2000 at approximately 0.35 percent of the total population (600,000 people). Most researchers and political actors agree that the success in HIV management has been highly correlated with some of the policies that the Brazilian government has implemented concerning the HIV/ AIDS positive population (Levi et al 2002; Dourado 2006; Parker 2009). With worldwide recognition of this accomplishment, one must wonder why it is that the North and Northeast regions of Brazil have been experiencing trends of increasing HIV/ AIDS incidence in the past decade (Nunn et al 2009). This study concentrates on the spatial distribution of HIV incidence in the year 2000, as it uncovers how HIV distribution can be related to aspects of marginalization in the second-most populous Northeastern municipality; Fortaleza, Brazil. The central hypothesis of this research states that HIV incidence is positively correlated with rate of marginalization. Marginalization is considered as the sector of population without access to basic social services, such as education, running water, and appropriate housing. Spatial patterns of HIV and marginalization are examined and interpreted in the context of the Brazilian Model**.** This research suggests that although marginalization has a strong spatial pattern, HIV is not demographically or geographically discriminatory.

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Chapter 1: Health Research and HIV/ AIDS

1.1 INTRODUCTION

The prevalence rate of the Human Immunodeficiency Virus (HIV) in Brazil has stabilized since the year 2000 at approximately 0.35% of the Brazilian population. Most researchers and political actors agree that this success in HIV management is related to some of the policies that the Brazilian government has implemented concerning the HIV positive population. With worldwide recognition of this accomplishment, one must wonder why it is that the North and Northeast regions of Brazil have recently been experiencing trends of increasing HIV/ AIDS prevalence in the past decade (Nunn et al 2009).

Based on reports from the Center for Global Health and the O Povo Newspaper, Fortaleza, the third largest Northeastern city in Brazil, has seen an increase of 54 percent in total HIV/AIDS cases, from 3,165 cases in the year 2000 to 4,884 cases in 2007 (De Lisser 2001; Guimarães 2007). A recent report found an increase in cases among marginalized individuals, particularly those with less education and living in poor outskirts of urban centers, enhancing their social vulnerability and poverty levels (UNAIDS 2008). Considering that the Brazilian Northeast has reported much higher levels of poverty than other regions (Ferreira et al 2003) and increased rates of AIDS incidence (Nunn et al 2009), it is possible that the Northeast has become more vulnerable to this pandemic as compared to other areas in Brazil.

This research focuses on the spatial distribution of new HIV cases in the year 2000. It also uncovers how HIV distribution can be related to aspects of marginalization in the municipality of Fortaleza in Northeastern Brazil. Due to the Sanitation Reform of 1985, the government is required to provide highly active antiretroviral medical therapy

(HAART) to all people living with HIV/AIDS (PLHIV) at no 'out-of-pocket' costs. Despite proactive policies to manage the spreading of the virus (HIV), current trends of HIV moving to impoverished areas and increasing HIV prevalence rates in the Northeastern regions of the country could be related to the lack of actual universal access of HAARTs which geographically excludes the socially marginalized and the poor (Peters et al 2008; Montenegro et al 2004; Parker 2002). This research examines the geographical distribution of HIV/ AIDS in Fortaleza and how the disease dissemination is associated with the socio-economic processes of the region, specifically marginalization as a barrier to health care access.

This research hypothesizes that HIV/ AIDS incidence rate is positively correlated with rate of marginalization, suggesting that areas with high rates of marginalization are correlated with high HIV/ AIDS incidence rate.

1.2 THEORIES OF HEALTH RELATED BEHAVIOR

Often, health related research is based on the models of bio-medicine and epidemiology, arguing that health is the absence of disease and thus, these models concentrate on understanding the physiological mechanisms of the disease or behavior patterns that lead to disease transmission (Kalipeni & Zulu 2010)**.** When applied to HIV research, this translates to a surge of preventative action through instigating safe sexual behavior, especially amongst high-risk communities, as well as, focusing biomedical studies on the management and assessment of viral loads for PLHIV, opportunistic and co-infections and preventing vertical transmission (from mother to child) (Kalipeni & Zulu 2010).

Recently, academic interests have reflected a growth in health research which incorporates geographical frameworks in order to discover spatial patterns and clusters of disease with hopes of accentuating social, economical and/or political complexities influencing illnesses which were previously unforeseen. In order to properly comprehend environmental influences on health behavior, we must first review earlier theories which continue to influence frameworks in the field of Health Geography.

There have also been several studies recently which analyze health standards as a factor of infrastructural, financial, or social development (Parker et al 2009; Peters et al 2008; Ramos et al 2009; Rhodes et at 2009; Scribner et al 2010). In particular, the studies show how the social and structural environments help shape risk behaviors that predispose a community to sexually transmitted infections (STIs), including HIV (Rhodes et al 2005; Hacker et al 2009; Ramos et al 2009). Indicators such as, access to sanitation, permanent shelter versus homelessness and migration are often incorporated when defining a risk environment for HIV/AIDS transmission. Although many theories of health behavior concentrate on the individual's accountability and how changes in attitude and individual thought can minimize risk-behavior, such as the health belief model (Becker 1994; Janz & Becker 1984; Rosenstock 1966) and the theory of reasoned action (Fishbein & Ajzen 1975; Jazen & Fishbein 1980); other theories attempt to incorporate the influences of structural factors in risk environments. The structural factors often analyzed are related to physical infrastructure, governmental organization and policies, and community coherency. Such theories include the socio-ecological model (McLeroy et al 1988; Stokols 1996) and the risk environment framework (Rhodes et al 1999), which look at macro-, meso- and micro-level factors acting as barriers and/or facilitators of disease (HIV) transmission.

1.2.1 Health Belief Model

Since the 1950s, social psychologists have been interested in human behavior towards diseases and specifically why there exists a widespread failure of disease prevention and detection (Rosenstock et al 1994). The years between the 1950s and 1980s brought about the development and expansion of the health belief model (HBM) by the U.S. Public Health Services and it has been one of the most used theories to explain health related behavior ever since.

At its core, the HBM is a value-expectancy theory which emphasizes that "behavior is a function of the subjective *value* of an outcome and of the subjective probability of *expectation* that a particular action will achieve that outcome" (Rosenstock, Strecher, and Becker 2004, 6). Therefore, the HBM's foundation relies on (1) the individual's desire to avoid illness (seen as the *value*) and (2) on the idea that a particular health action will ameliorate illness (seen as the *expectation*). Another agreed upon influence is that the individual's perspective of their own susceptibility to an illness and how they are able to reduce or prevent such susceptibility will act as two interacting values influencing the final health behavior; defined by Hochbaum in 1958 as, perceived susceptibility and perceived benefits (Rosenstock, Strecher, and Becker 2004).

Central to the HBM is the notion of *perceived threat*, which is a combination of perceived susceptibility and perceived severity. The difference between these two ideas is that perceived susceptibility refers to an individual's perception of contracting an illness whereas perceived severity relates to one's belief of the seriousness of said illness, importance of treatment and possible social consequences of contracting the illness (Rosenstock, Strecher, and Becker 2004). Health action is then taken based on one's perceived benefits, barriers, and cues to action. The perceived benefits and barriers can be thought of as a cost-benefit analysis, where the individual weighs the effectiveness of

participating in preventative behavior and adhering to medical regimes as opposed to the difficulties encountered by said health behaviors, such as expensive medication, dangerous side effects, inconvenience, and time costliness (Rosenstock 1974). These perceptions are often influenced by upbringing, family, friends, media, teachers, and so on; referred to as cues to action. A widely used description of the HBM is shown below:

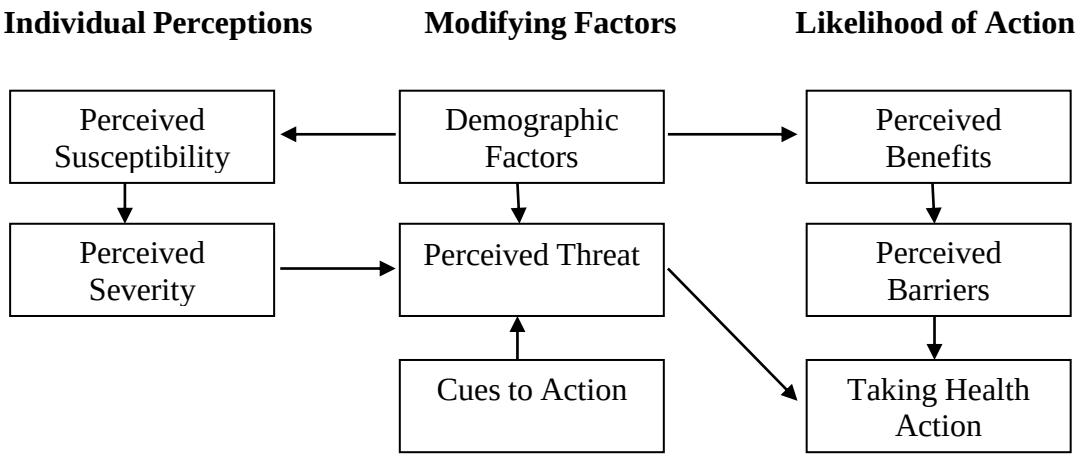

Figure 1.1: Health Belief Model (Hazavehei, Taghdisi, & Saidi 2007)

Pertaining to HIV/ AIDS, the HBM attempts to explain the psychological reasons why individuals do not strive to find out their sero-status do not partake in safe sex behavior (i.e. using condoms) and do not seek medical care after the discovery of being seropositive. Misguided notions of HIV being a homosexual disease, for instance, may influence one's perceived susceptibility to the virus and result in the lack of preventative action by a heterosexual individual. On the contrary, an individual may not be aware of his/her susceptibility to acquire the virus, but if s/he perceives the illness to be of high severity then it persuades the individual to enforce safe-sex regiments. These examples do not aim to explain all thought process related to health behavior concerning HIV, but

they serve to aid our understanding of how this model is directly applied to HIV/ AIDS research.

Critics of the HBM have argued that the model does not take into account social and economic influences as a predictor of health related behavior and thus is best suited to predict health behavior amongst peoples of higher socioeconomic status especially those with heightened awareness of health related matters (Terry, Gallois, and McCamish 1991). The HBM is also considered problematic when predicting non-discrete health behavior, in other words, behaviors that impact not only the individual but also the person's relations with others, such as safer sex practices. Terry, Gallois and McCamish (1991) have argued that in this respect, the theory of reasoned action is more applicable due to its holistic framework which incorporates not only one's beliefs, but also the role of others outside the individual that influence health related behavior. This is particularly important with matters regarding safer sex behavior and consequently important for HIV preventative action.

1.2.2 Theory of Reasoned Action

Formulated in the late 1960s by Ajzen and Fishbein as a response to the failing methods of the time to predict behavior (Fishbein 1991), the Theory of reasoned action (TRA), similarly to the HBM, is based on cognitive factors that act as determinants of health care behavior. Both models argue that attitude towards and beliefs of susceptibility and severity are directly correlated with the intention to take action (Ajzen & Fishbein 1980). The TRA holds as its main variables the following four components: beliefs, attitudes, intentions and behaviors. It is based on the assumption that attitudes are learned and that "beliefs are based on or influenced by prior information to the individual" (Ajzen 1975; 510), therefore action (*behavior*) is consequently influenced by the predisposition

of an individual to a past experience. Also based on an expectancy-value model (as the HBM), this theory suggests that "a person's attitude toward any object is a function of his or her beliefs about the object" (Fishbein 1991, pg. *xvi*).

Below is the conceptual model of the TRA according to Terry, Gallois and McCarnish (1993):

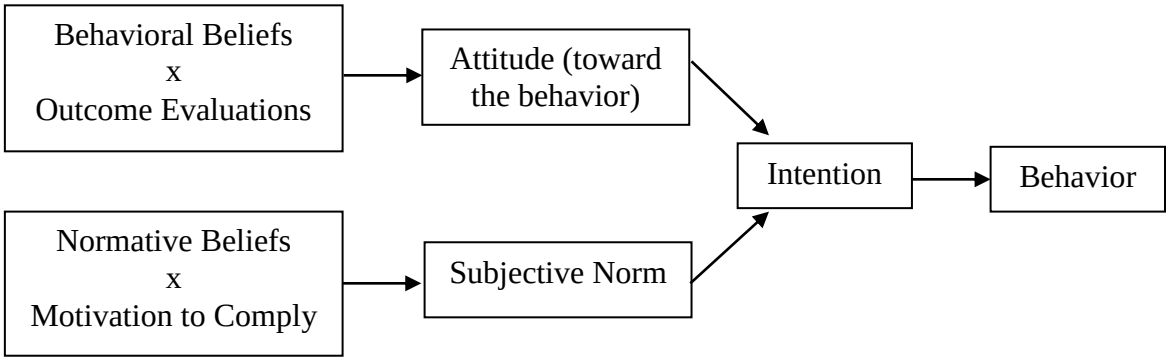

Figure 1.2: The Theory of Reasoned Action (Terry, Gallois, & McCarnish 1993)

As the model above shows, the TRA is founded on the notion that one's behavior is directly and exponentially correlated to one's intention to perform such behavior. Attitudes and subjective norms are the primary influences on one's *intention* in the TRA, where *subjective norm* refers to the perception of others upon one's behavior and *attitude* is a measure of one's own evaluation of positive or negative opinion of such behavior. To further explain the conceptual model above, understanding the compositions of one's attitude and subjective norms are essential. *Attitudes* toward a behavior are shaped by the individual's beliefs towards that particular behavior (*behavioral beliefs*) weighted by the associated consequences of proceeding with that behavior (*outcome evaluations*). *Subjective norm* is a function of one's perception of the pressure imposed by others to partake in a behavior (*normative beliefs*), weighted by the need to comply to such pressures (*motivation to comply*) (Terry, Gallois, and McCamish 1991). In other words, if

someone important to an individual believes that s/he should or should not perform such behavior, this will influence the final action although not as heavily as the individual's personal association of the behavior, be it either positive or negative (e.g. like-dislike, necessary-unnecessary, bad-good) (Albarracín et al 2001).

In 1980, Ajzen modified the Theory of reasoned action due to the realization that not all action appeared to be voluntary and under the control of the individual, and called this extension of the TRA, the theory of planned behavior (TpB). The central factor of the theory remained the same, where the intention to perform a behavior is a function of actually partaking in said behavior. But Ajzen recognized the influence of motivational factors, such as time, money, skills and the cooperation of other which collectively represents one's control of certain behavior. He then added the variable of *control beliefs* which refers to the individual's perception of their ability to partake in a behavior (Ajzen 1991) and currently, the TpB is often presented in conjunction with TRA. The TpB is shown below:

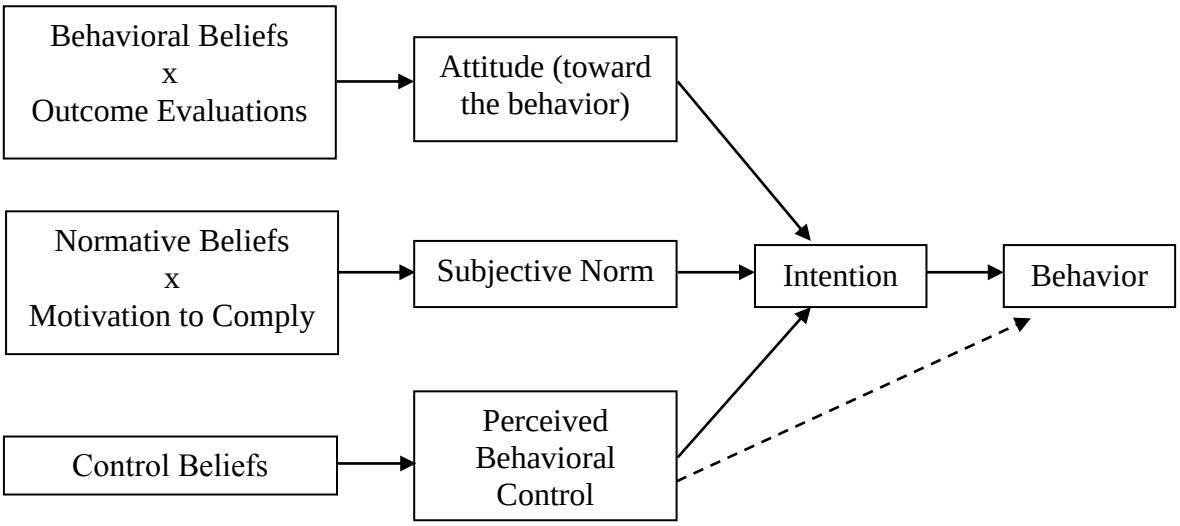

Figure 1.3: Theory of Planned Behavior (Ajzen 1991)

The theories presented above have been demonstrated to be useful in the arena of health care behavior, in particular in studies related to safer sex behavior (see Pomazal & Brown 1977; Brinberg & Durand 1983; Fishbein 1980; Fisher & Fisher 1992). Thus, the use of the TRA and TpB are dominant in the battle against HIV/AIDS today. In the words of Fishbein (1991, pg. *xxi*), "fortunately, it is not who one is, but what one does, that determines whether one will or will not be exposed to HIV [...] thus, the battle to prevent AIDS is a behavioural battle". But perhaps a criticism of the TRA is that it poses that "behavioural decisions are seen to be consequences of the person's systematic consideration and deliberation of the information available to him or her" (Terry, Gallois, & McCamish 1991, 8). Such an assumption excludes ecological and environmental factors that may interact and influence an individual's behavior.

Although behavioral-based studies have provided useful insights towards the management of HIV, specifically about associations of high-risk patterns of sexual behavior and HIV, they have been deemed inadequate because they fail "to focus on those social, political, cultural and economic factors that generate conditions of vulnerability to HIV and limit individual choices concerning social and sexual practices" (Kalipeni & Zulu 2010, 2; Scribner et al 2010). Behavioral-based insights have led to impactful programs concerning educational outreach and condom use, but concentrating on these programs exclusively assumes that "individuals can automatically change their behaviors with the benefit of awareness and condom possession" (Kalipeni & Zulu 2010, 2), excluding the root causes of HIV. Individual choice concerning social and sexual practice is limited by conditions that generate vulnerability to HIV that are not incorporated in behavioral-based studies, such as social, political, cultural, and economic factors (Kalipeni & Zulu 2010).

1.2.3 Socio-Ecological Model

Historically, HIV prevention strategies were based on education and individual behavioral change. Adopting behavioral interventions in conjunction with improving the public's understanding of behaviors associated with HIV transmission in the hopes that such knowledge would result in responsible sexual behavior in individuals were key intervention strategies during the second decade of the HIV pandemic. Now after three decades of the discovery of HIV/ AIDS, many agree that individual behavior change is complex and encapsulated in a large network of belief systems, customs, gender differences, inequity, and culture (Kalipeni & Zulu 2010; Scribner et al 2010; Yeboah 2007; DiClemente et al 2004).

In opposition to the bio-medical model and to the behavior-based models, the socio-ecological framework was developed, which is based on the interaction of environmental elements and one's well-being. Also called ecological epidemiology (Scribner 2010) among other names (see Glass & McAtee 2006), it incorporates an interactive relationship between people and the social, cultural, and physical aspects of their surroundings (Kearns 1993). As mentioned earlier in this chapter, the bio-medical philosophy refers to a curative model with a central element of disease elimination, based on the need to specify etiology, interpret symptoms and cure the patient. As Glass & McAtee (2006, 1664) lament, "the study of health behavior in isolation from the broader social and environmental context is incomplete, and has contributed to disappointing results". A shift in emphasis and introduction of new methods in health research has been suggested and emphasized in the recent literature. In order for the introduction of more holistic methods, there must exist an integration of multi scale analyses where links are made between the impacts of (1) "casual forces across the topography of social structure" (Glass & McAtee 2006, 1664), (2) across environmental interactions in one's lifetime,

and (3) through understanding how such influences are embodied in the social context. Incorporating comprehensive perspectives in academic research would prove heightened relevance in today's experience and understanding of health and illness (Kearns 1993).

The socio-ecological framework is typically depicted as concentric circles (see illustration 2.4 below) which represent multiple levels of macro- and micro-social factors that impact health outcomes. The macro-social variables include the societal and communal sectors and the micro-social factors are interpreted as the interpersonal and individual spheres. Together they reflect constraining or promoting risk-related individual-level behavior. Thus, the framework does not directly imply the association between health outcome and environmental and social constructs. Instead it operates as a dynamic multilevel interaction of contextual factors working together to categorize disease risk (Glass & McAtee 2006). Specifically, the *individual's* characteristics, sexual behavior, substance abuse and so on, span within his/her *interpersonal* and sexual networks, levels of trust and situation/setting. This larger context of where one's *neighborhood* is located, the density of one's living quarters, social norms and expectations are all shaping the previously mentioned micro-social factors. Lastly, all of these interactions and health-related behaviors occur within a *societal* umbrella where racism, stigma, segregation, institutions, and public health policy are engaging and defining risk environments and behavior much like a trickle-down effect.

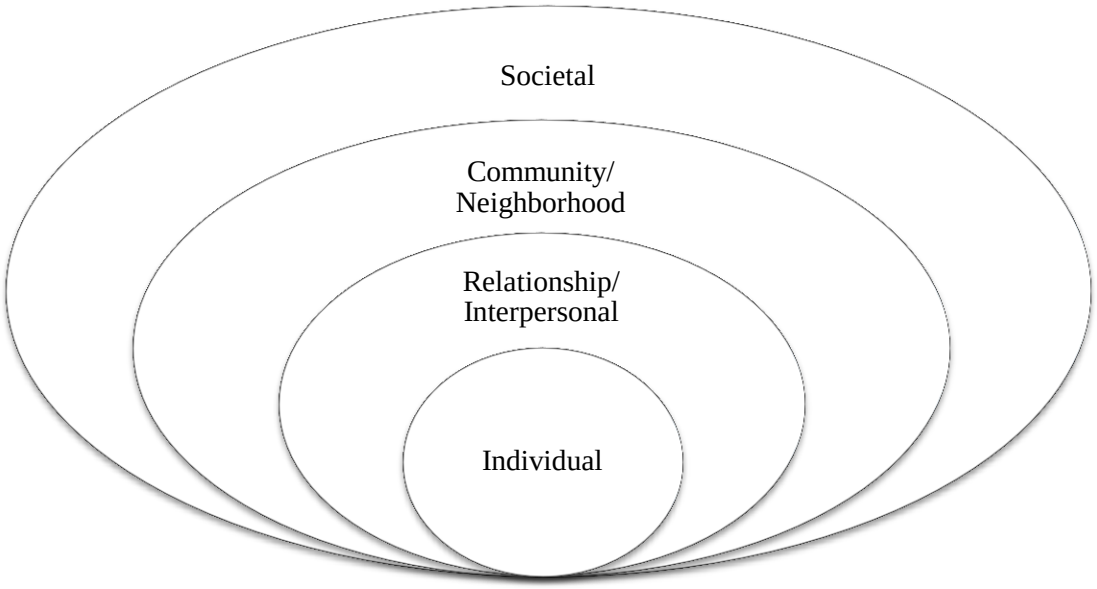

Figure 1.4: The Socio-Ecological Model (Scribner et al 2010)

Differing perspectives on the application of the social-ecological framework when conducting HIV related research can be found in the recent literature. Glass & McAtee (2006) argue that the macro- and micro- variables can be thought of as risk-regulators making a particular health outcome more or less likely through influences on individual-level factors. DiClemente et al (2004) consider that the sexually transmitted infection (STI) epidemic occurs within a psychosocial and cultural phenomenon. It is especially important to incorporate frameworks which expand beyond individual behavior change when researching STIs among adolescents and young adults due to the strong influences of their peers, family members and partners (DiClemente et al 2004). Scribner et al (2010) created a more explicit version of the socio-ecological model, in order to characterize the role of environments prone to alcohol use on the spread of HIV. Below is an adapted version of the model (see Figure 1.5). Furthermore, they argue that within sexual networks there are both structural and compositional factors which impact disease

transmission, where density and mixing (structural) and member characteristics (compositional) are all important variables. It is also important to note that members of a particular sexual network tend to be geographically clustered (Scribner et al 2010).

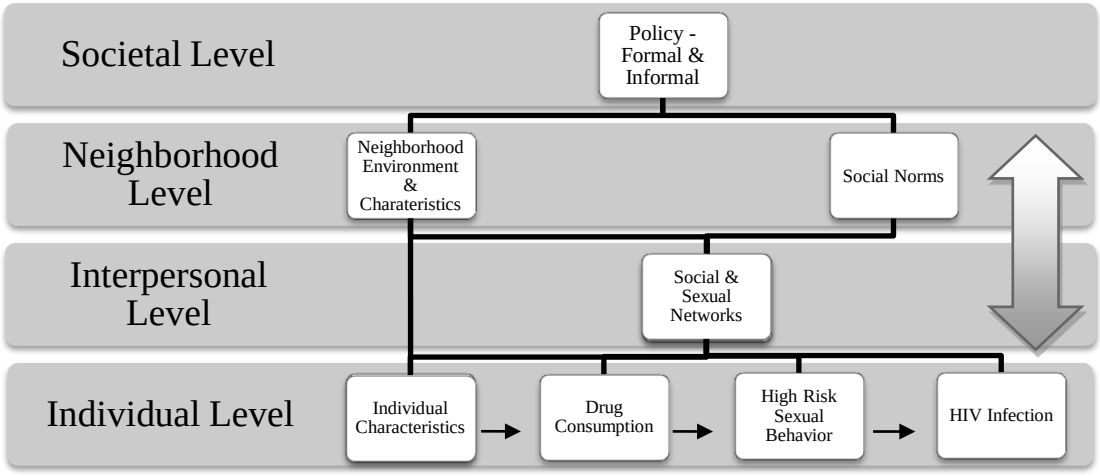

Figure 1.5: Adapted conceptual model of HIV risk from an ecological perspective (Scribner et al 2010).

1.2.4 Risk-Environment Framework

To a large extent, HIV research remains concerned with prevention strategies and promoting behavior change and as a result, it has been important to understand the psychological theories that have been traditionally applied to HIV research. What is important to remember is that there are external forces influencing human behavior and at times these forces are outside an individual's control. For example, one may have the *intention*/ *rationale* to partake in certain preventative behaviors, but in practice environmental factors may serve as a barrier to such intended accomplishment. These can be anywhere from social pressure, cultural expectations and norms, historical influences,

gender-related barriers, socio-demographic hurdles and political climate and intervention, to name a few.

The risk-environment framework is similar to the socio-ecological model, in the sense that it also attempts to diverge from individualist models of behavior change and offers the emphasis on 'risk-environments' as a units of analysis (Rhodes 2002). The 'risk-environment' is defined by Rhodes (2002) as a variety of factors from the social or physical environment interacting to produce an increase in health risk. Although often used as a means to measure risk and vulnerability within drug-injecting communities and HIV, this research uses the risk-environment framework in conjunction with the socio-ecological framework to analyze marginalized clusters in urban settings as a 'risk-environment', independent of observed drug use. Specifically, how favelas can create environments of risk for HIV infections through sustaining social and physical factors often correlated with health risk.

Within the risk environment framework, one analyzes the type and level of environmental influence. HIV prevention research tends to concentrate on four types of environments: physical, social, economic, and political. These are usually analyzed at two levels, (1) the micro-risk environment, encompassing personal decisions and community practices and (2) the macro-risk environment encapsulating economic conditions, laws and wider cultural beliefs (Rhodes & Simic 2005). There has been a growing interest in macro-risk environment research, particularly studying the gender, social, and economic inequalities and how it pertains to risk production or reduction, as well as, cultural and political organization of risk and harm. Other important macro-factors explicitly impacting micro-risk environments are public health and health related economic policies and discourses. For a better understanding of differing multi-scale environments directly influencing HIV transmission, refer to table 1.1 below:

	Micro-Environment	Macro-Environment
Physical	Sex work sites Prisons and detention centers Temporary or improvised housing	Labor mobility Urban and economic migration Geographical dispersal of population
Social	Peer and social norms Community attitudes Local policing practices Community health and welfare services	Social and cultural norms and values National and cultural identity Gender and social inequalities Stigmatization and marginalization of social groups Civil society and societal infrastructure
Economic	Cost of living and health care Income generation Informal local economies Economic Enterprise	Economic regulation and development Public and health service revenue and spend Employment norms and practices
Policy	Distribution of condoms Distribution of HAART City Regulations	Laws governing trade and migration Laws governing sex and consent Laws governing health, welfare, and citizen rights

Table 1.1: Simple model of HIV risk-environment (Rhodes & Simic 2005)

An analysis by the United Nations (UNDP 2009) of life expectancy, education, and gross domestic product (GDP), has produced the human development index (HDI) which has been beneficial in correlating health, infrastructure and disease transmission. Countries are ranked by level of development (high, medium, and low) representative of their HDI, where a higher index score suggests increased development. Studies have shown an inverse relationship between AIDS rates and areas with high scores on the HDI. In addition to the HDI, indicators of accessibility, such as distance to/from highways and railroads, were also found to be inversely associated with HIV/AIDS transmission (Hacker et al 2009). Therefore, the risk-environment framework is useful because it emphasizes the social processes, structures and situations under which all

individual behavior occur. Moreover, HIV prevention research has demonstrated that large scale community support is necessary to support individual behavior change. According to Rhodes & Simic (2005, 331), there needs to be a "broader and long term vision for health intervention that encompasses alleviation of poverty, economic reform, policy change, human rights, and community action".

1.3 Issues of Marginalization & Accessibility

Concepts of poverty and accessibility dominate the discourse related to health and HIV/ AIDS research. This is in part because poverty is significantly correlated with HIV rates, typically demonstrating positive correlation; as poverty level increases in a particular area, so does the prevalence rate of HIV in that same area (Moise & Kalipeni 2010). But, as some authors have discovered, the current measures of socio-economic status (SES), such as education and income, may not serve as the best parameters to analyze the impact of social class on health (Drewnowski, Rehm, & Solet 2007).

Poverty continues to be used as an indicator of health risk because individuals living in poverty tend to experience social, psychological, and physical risks that are related to worsened health (Holt 2007). Such psychological stresses increase unhealthy behavior that can go unprotected because of lower access to health information, health services, and technologies (Holt 2007). There is a growing consensus that poverty is best represented as a set of opportunities and constraints produced through multiple independent attributes interacting with other social and structural forces (Holt 2007). Due to this consensus, marginalization indices are now emerging in health research (Lorant et al 2001) because when these attributes are agglomerated as indices (or social

determinants of health) they hold important proximate and distal impact on health behavior and outcome. (Holt 2007).

Although poverty is an important and effective factor to use in health research, it is disparity or relative deprivation that serves as a better indicator of potential HIV transmission. Utilizing relative deprivation allows for the incorporation of external factors, such as social services, political leadership, and health infrastructure, can influence health outcomes as opposed to looking at poverty rates alone (Drewnowski et al 2007, Parkhurst & Lush 2004). Studies have shown that the likelihood of higher HIV transmission is directly linked to urban living, especially since there are significant negative associations between HIV prevalence and rural residents (Gisselquist et al 2003; Potts 2003; Moise & Kalipeni 2010). Further research is needed that combines HIV surveillance data with socio-economic, demographic, and cultural variables, and further investigates for significant relationships (Moise & Kalipeni 2010). According to Drewnowski, Rehm, & Solet (2007, 2460), sapient perspectives of social determinants of health can arise from geocoding health data since it can aid in the examination of geographical factors which may increase the risk of HIV infection.

Health care equity research is largely based on theories of accessibility, typically including four dimensions: (1) geographic accessibility, (2) availability, (3) affordability and (4) acceptability (Peters et al 2008). These are often divided into spatial and non-spatial components. The socio-organizational aspects- affordability and acceptability- represent the non-spatial attributes that hinder or facilitate the acquisition of medical care. Geographical accessibility and availability are thus considered spatial factors. While physical accessibility refers to distance or travel time to the delivery of services, availability incorporates aspects of time spent waiting for care, appropriateness of service provided based of the medical need, hours of operation and material availability (drugs,

syringes, etc.). Affordability, or financial accessibility, has typically dominated the health care accessibility debates due to out-of-pocket costs for patients, which lead to an implicit exclusion of the lower-economic population. In the case of countries which provide universal health coverage, issues of affordability focus on indirect costs, such as, transportation, opportunity cost of time, and expenses for lodging and food. Acceptability holds the most complex aspect of accessibility, for it attempts to analyze the capacity of the health care services to match cultural necessities and expectations, while integrating issues of stigma and discrimination.

Deconstructing stigma as a concept does not have a universal prescription, for it can be argued that it is a socially constructed notion which continues to emphasize the role of the other through relations symptomatic of inclusion and exclusion. According to Goffman (1963), stigma is an attribute that serves to discredit and negatively differentiate the stigmatized individual. Conversely, Parker & Agglenton (2003) found that providing stagnant definitions for 'stigma' is in itself, problematic and limiting. In Goffman's definition, stigma is seen as *something* imposed on the individual by *outsiders*, society, or institutions and it leaves no room for the internalized perceptions of the stigmatized individual and the repercussions for social interactions; including seeking medical care (Parker et al 2003).

1.4 STIGMA AND DISCRIMINATION

> "Stigma remains the single most important barrier to public action. It is a main reason why too many people are afraid to see a doctor to determine whether they have the disease, or to seek treatment if so. It helps make AIDS the silent killer, because people fear the social disgrace of speaking about it, or taking easily available precautions. Stigma is a chief reason why the AIDS epidemic continues to devastate societies around the world." *Ban Ki-Moon in 2008, Secretary General of the United Nations*

In 1948 the United Nations (UN) adopted the Universal Declaration of Human Rights, in which it proclaims that "everyone has the right to a standard of living adequate for the health and well-being of oneself and one's family, including food, clothing, and medical care" (NHCHC 2009, Article 25). The United Nations Educational, Scientific and Cultural Organization (UNESCO) has focused its HIV and Human Rights work on confronting HIV-related stigma and discrimination for it believes the virus is in its Fourth Wave, one which incorporates violence, gender and culture to its epidemic (UNESCO 2009). Although many inter-governmental organizations (IGOs), including the UN and its entities, are influencing and promoting States to confront HIV-related stigma, the community of PLHIV are still highly affected by perpetuated acts of discrimination.

Stigma and discrimination have often been recognized as crucial components of the fight against HIV/AIDS (Eba 2007; Parker & Aggleton 2003). Research concentrated on the acceptability of health care aims to analyze the cultural matching between the medical care provided and the needs of a certain population. As Parker et al (2003, 1) states, "rarely are existing notions of stigma and discrimination interrogated for their conceptual adequacy and their usefulness in leading to the design of effective programs and interventions." Perhaps notions of stigma and discrimination are not only hindering the design of successful programs, but are also a cause of deterrence for patients to seek out that intervention or treatment.

There exists a growing interest in analyzing and interpreting national and international health campaigns and discourses, to find how they helped shape the susceptibility towards seeking treatment, prevention, and vulnerability to the HIV (Romer et al 2009; Noar 2006). In other words, aside from medical reasons, do people feel ashamed about their HIV status? How much of this top-down communication influences the stigmatization of the disease, or even of certain sub-cultures (known as the 'at risk

population')? Is this hindering or helping: 1 – awareness of the HIV/AIDS spread? 2 – accessibility to HIV treatment? 3 – HIV-related stigma?

1.4.1 Why is HIV/ AIDS so stigmatized?

According to Erving Goffman (1963), stigma is an identification that is socially constructed, based on perceived social, behavioral, or physical characteristics, which are then used to exclude the individual from a social group in which he/she was previously identified with (Eba 2007; Goffman 1963). Farmer & Castro (2005), developing on Goffman's idea stated that stigma is not only based on relationships, but relationships of power which lead to structural violence: "Stigma and discrimination [as is relates to HIV/ADIS] are part of complex systems of beliefs about illness and disease that are often grounded in social inequalities" (Farmer & Castro 2005, 53). A frequent response to cope with stigma is when the person hides themselves or their HIV status as an attempt to pass as normal (Goffman 1963). Encouraging PLHIV not to hide and not to fear their HIV-positive status has been the focus for some of the Brazilian national campaigns.

HIV/AIDS presents additional complexities to the notions of stigma and discrimination because it forces the population to confront delicate cultural matters, normally enshrined in their beliefs. Aspects of life and death (and life after death) inevitably arise due to the biology of the disease, as well as, proper sexual etiquette, gender roles, and often, religion. Perceptions of self may change based on differing dialogues communicated in differing places, for self and place are inherently entwined (Adams 2009). For example, accepted behaviors in the nucleus of the home often differ from accepted behavior and communication in a work or public environment. Just as one individual occupies multiple roles, stigma (specially the symbolic stigma) can also be multi-layered and be superposed in these roles or groups (Eba 2007). Depending on the

context, signifiers such as, 'voracious black male', 'a foreigner', and 'a homosexual' could be negatively charged, further stigmatizing that individual or group. Women could be stigmatized as 'black', 'poor, 'loose', 'a woman' and 'HIV positive'. Place becomes essential when discussing the embedded cultural attitudes, because it is usually created and shaped in the home.

The International Centre for Research on Women (ICRW) presented possible consequences of HIV-related stigma, much of which can be related back to the home and role of the family. Those consequences are: (1) loss of income/livelihood, (2) loss of marriage & childbearing options, (3) poor care within the health sector, (4) withdrawal of care-giving in the home, (5) loss of hope & feelings of worthlessness, and (6) loss of reputation (AVERT 2010). Sub-Saharan Africa, for example, has very low percentages of people receiving HIV treatment (WHO & UNAIDS 2006). Due to an acceleration of HIV to AIDS (due to the lack of medication), the people living with HIV (PLHIV) are still represented as emaciated bodies in the terminal stages of their lives. This image continues to be perpetuated, as those with access to ARVs, and therefore a 'healthy' appearance, perceive that it is necessary to maintain their HIV status private due to discrimination. In this example, it could be argued that if those with access to ARVs were to expose their HIV status and demonstrate the normalcy of PLHIV, then perhaps the overall public's perception of AIDS as a deadly condition would be altered. Instead, the emancipated body becomes a symbol for AIDS as a toxic, fatal, debilitating and humiliating disease. If this symbol becomes strong enough, it could turn into a signal for social distancing, exclusion, avoidance, and maybe even disgust which manifests itself in the form of stigma and discrimination.

Associating AIDS only with deviant behavior can hold negative consequences for a society, especially when these negative notions are rendered in legal repercussions. If

large segments of a community/society harbor beliefs that PLHIV are morally condemnable or even deserving of their HIV-positive status, any government policy or intervention considered to benefit PLHIV will be received with high criticism and "generate negative reactions towards government policy and PLHIV" (Eba 2007, 37). In extreme cases, the social pressure could prohibit any interventions from being implemented at all, or lead to denial of a local epidemic.

According to a report published by the Pan American Health Organization (PAHO) in 2008, "various studies have found that the people who have experienced negative attitudes toward their own sexuality tend to have low self-esteem and less social support" (PAHO 2008, p10; Huebner 2002; Seal et al 2000; Williamson 2000). The epidemic of fear hinders open communication to occur between PLHIV and their families, perpetuating stigma and accentuating a loss of personal agency. This results in individuals having more difficulty practicing safer sex, protecting themselves, asking for or providing support to their social networks and only further complicates attitudes towards HIV testing, disclosure of HIV status, family planning and ability to negotiate prevention behaviors (ICRW 2005). The World Health Organization (WHO) has also stated that fear of discrimination is the main reason why people are reluctant to be tested, disclose their HIV status, counseling or seek treatment. Homosexual men often make up a large segment of the 'at-risk' population and therefore have been main targets in health interventions and HIV-related discourse. Due to marginalization, sexual minority and association of moral deviance, homosexuals experience additional social exclusion, similarly to PLHIV, with smaller social support networks and consequently suffering from loneliness and low self-esteem (PAHO 2008). For these reasons, homosexuals tend to be the 'face' of the HIV pandemic (in addition to the historical association with AIDS)

and continue to be associated with HIV awareness movements and anti-stigma interventions.

1.5 GEOGRAPHY AND HEALTH

The correlation between the physical environment and health has been observed since the time of the ancient Greek philosopher, Hippocrates, who in circa 400 B.C. formally correlated human culture, disease, and environment (Barrett 2000). Formal academic interest in the geography of health did not begin until the 1950s when the development of Medical/Health Geography as a distinct geographic subfield (Gesler 2003), emerged with Jacque May's publication of The Ecology of Disease in 1958 (Meade 2000). But a decade earlier, the production of maps depicting disease distribution appeared in an impactful manner when in 1854; John Snow correctly presented a plausible causation of cholera in London through the use of cartography. Considered the father of modern medical geography, "Snow's greatest contribution to an understanding of epidemic disease and community health" was bringing the attention back to how variations in topography impact disease trajectory (Koch 2005, 249). Although Snow's spatial analyses were based only on visual examinations of maps, his innovative approach continues to influence academic research to this day.

One such influence can be found in the works of Peter Gould, who in 1993 became the first person to ever map the diffusion of HIV incidence, by year. As early as 1986, only a few years after the discovery of HIV, Gould expressed frustration at the lack of spatial thinking coming from epidemiologists by stating that they "appear oblivious to where the epidemic is...asking only when numbers will appear along the time horizon" (Gould et al 1991, 82). Also frustrated by the public health sector's inability to educate on safer sex practices and on the potential of acquiring the virus, Gould's main research

interest was to understand how things spread across time and space. Specifically, he aimed to explicitly demonstrate to his students the diffusion of HIV. Through the use of spatial statistics, Gould developed a tool to predict the diffusion of AIDS in the United States. With a 96 percent accuracy rate on the predictions, Gould's maps brought light to the shocking reality of this epidemic, advanced the field of epidemiology and presented a probable future of contagion.

Gould also described the interconnectedness of HIV with social and geographical spaces, and illustrated hierarchical spatial diffusion of the disease. Although not formally following a socio-ecological model, Gould's work reflected this framework by referring to the limitations of choice in individual behavior, by expanding the notion of risk-environments and by strongly arguing about the impacts of bureaucratic barriers and policies on the spread of HIV. He further highlights the "importance of geography and the need for mapping to predict the geographic future of the epidemic and to plan for the distribution of appropriate health-care facilities and personnel" (Shannon 1994, 760).

Considering health as one's self-assessment on the quality of life, especially through a socio-ecological perspective, there lies an implicit redirecting of health care behavior from purely curative to preventive action. According to Kearns (1993), this redefinition of health implies an importance to the relationship between people and place and endorses the power of places to ameliorate health, allowing geographers to play a central role in this new paradigm.

1.5.1 Spatial analysis applications in health geography

Health geography is one of the fastest growing fields within geography, in part due to the immense development and accessibility of research and analytical tools, such as, geographic information systems (GIS), remote sensing (RS), global positioning

systems (GPS) and spatial statistics (Cano et al 2007). The importance of GIS to health research can be exemplified by the rapidly emerging publications in this field, especially regarding infectious diseases. In practical terms, GIS is often used for siting new hospitals, determining market areas, routing emergencies, predicting the spread of a toxic chemical, and of infectious diseases (Kalipeni & Zulu 2010, Osei & Duker 2008, Holt 2007, Zenk et al 2005). GIS has helped medical research in understanding how health is related to space through integrating complex temporal data and spatial data. According to Logan, Zhang & Xu (2010), spatial analyses are important to health research because they highlight concepts of proximity and access, isolation or exposure, neighborhoods effects and boundaries, and diffusion. Growing spatial insight and databases from the following sectors have greatly impacted the health arena: demographic, political, environmental, ecological, topographical, hydrological, climatic, land-use, public infrastructure, transportation, health infrastructure, and epidemiological (Kistermann et al 2002; Kamel Boulos et al 2001).

Health related events can be detected through the use of spatial analysis, distinguishing clusters of high or low disease prevalence (Waller & Gottway 2004). The most important purpose of detecting spatial patterns is to be able to identify geographic size and shape of clusters, locations of spatial outliers, boundary shapes and, through the use of spatial statistics, quantify the magnitude of high or low values (Fotheringham et al 2002). Once cluster detection has been accomplished, then hypotheses and testable explanations can then be generated which attempt to give insight as to the cause of these patterns. One of the fundamental concepts behind using spatial analysis in health research is spatial autocorrelation, which reflects that data from locations near one another in space are more likely to be similar than data from distant locations (Anselin 1995). With

health research, this proves to be a useful approach to discover areas of high disease burden and potential risk factors.

1.5.2 Types of spatial statistics employed in health research

Spatial statistics and cluster detection can be undertaken with a multitude of spatial statistical tests, of which a few will be discussed in this section. Many of these tests can be divided into two categories, *global* and *local* spatial statistical tests (Anselin 1995). A short discussion of these methods and their applications in health research will follow and they will be further explored in the methodology chapter of this work (Chapter 3).

Both global and local statistics can be used to identify spatial processes, and determine whether a pattern exists. Global spatial statistics yield one statistic to summarize spatial autocorrelation over the entire study area whereas local spatial statistics are used to find and quantify clusters at a local level. Moran's I and the Getis-Ord General G are utilized as indices of spatial autocorrelation, which are used as indicators of spatial patterns of diseases by taking into consideration the location of the cases (incidence) and their values (the number of cases) (Moran 1948). These indices aid in the identification of clustered, random, or dispersed patterns in a particular study area. Anselin's (1995) local indicator of spatial autocorrelation (LISA) is one of the most commonly utilized tests for local spatial autocorrelation, for it detects disease hotspots. The disease hotspots are identified by measuring whether disease incidences are geography clustered, distinguishing between clusters of high values and low values. Local spatial statistics tests, such as LISA, are deemed essential for health studies because they reveal spatial dependency in small localities (Dean et al 2005). Spatial

analyses were used in this research to investigate the spatial patterns of HIV incidence and marginalization in Fortaleza in the year 2000.

Spatial autocorrelation analysis has been readily employed in health research lately. For example, Montenegro et al (2004) used spatial analyses to determine the distribution of leprosy in the state of Ceará, Brazil and were able to identify possible underlying factors behind the spatial clustering of the disease, such as crowding and social inequality. Peng et al (2011) applied global and local spatial analysis in their study of HIV/AIDS spatial distribution in order to guide the direction of HIV prevention interventions in China; recommending that such interventions concentrate in Yunnan province which borders Laos and Vietnam and reflects the possible entry of the disease in the county. Moise & Kalipeni (2010) also interested in HIV/AIDS, applied spatial statistics (Moran's *I*) to socio-economic and demographic data in order to characterize the epidemic in Zambia. Similarly to this study, Moise & Kalipeni considered literacy rates, unemployment poverty and urban density as factors of HIV incidence. Deprivation and mortality have also been analyzed through spatial statistics by Lorent et al (2001) who investigated the implications of spatial autocorrelation for health resource allocation and discovered that mortality, morbidity, and socio-economic status all show high spatial autocorrelation, thus demonstrating the importance of spatial analyses in health research.

1.6 CONCLUSION

This chapter touched upon the different behavior based models of research as compared to frameworks which attempt to incorporate the social and physical environments into the theories of health research. Although individual behavior is extremely important for disease management, many in the health field have accepted that

not all health behavior is rational nor under an individual's complete control. Furthermore, there are factors beyond a person's control (such as social inequality) which influence health behavior and disease activity that must therefore be included in order to gain a comprehensive understanding of the variables dictating health and illness.

Geographic theories and tools have recently enriched the field of health research and seem to be contributing important perspectives on many health-related concerns. Disease movements and clusters, health care accessibility, and medical resource allocation are only some of the areas that have benefited from a geographic outlook on health. One of the most tangible tools geographers can offer the field of health research is GIS. Among the multitude of applications in GIS, statistically significant processes and analysis can provide clues on spatial patterns of disease. In addition to such spatial investigations, a geographer's understanding of the interactions between people, space, place, and environment can prove to be essential to public health in the future.

It is important to note that to date there is still no vaccine for HIV or medical cure for AIDS, and thus efforts to influence or change high-risk behaviors remain the only means to prevent HIV infection. Henceforth is the importance of understanding the social, psychological, cultural, and geographical variables influencing the ability to manage the epidemic. Often, these impacts are considered obstacles towards curtailing the spread of HIV and the vulnerability of certain population groups, but in opposition, some have incorporated cultural insight and traditions to construct prevention strategies which prevail in this worldwide public health fight (DiClemente and Peterson 1994).

Chapter 2: A General Overview of HIV in Brazil

2.1 Brazil's Approach to HIV/ AIDS Management

The first case of HIV in Brazil was diagnosed in 1982. Now, almost three decades later, HIV/AIDS has grown from isolated epidemics to a global pandemic, and while no country has been completely successful in managing this disease, the Brazilian response has been deemed one of the most effective in the world (Parker 2009). The fall of the military dictatorship in 1985 brought about the re-democratization of Brazil. The AIDS awareness movement contributed to a broader social desire to partake in governance and pressure towards government action, which included; the sanitary reform movement, the civil-rights movements, and the gay liberation movement (Paiva et al 2002). When the rewriting of the new Constitution of the Federative Republic of Brazil occurred in 1988, it articulated the legal basis for universal access to health care services as "the right of all citizens and the duty of the State" (Article 196, Brazilian Constitution). A broad-based collaboration and productive coalition of academics, public health care professionals, non-governmental organizations (NGOs), and a 'progressive' Catholic Church, in addition to the social oversight of health care policies, resulted in an effortless passing of legislation aimed at managing the spread of HIV/AIDS in the mid 1990's (Parker 2009; Paiva et al 2002; Levi et al 2002; ABIA 2001). During the 1996 International Conference on AIDS in Vancouver, Canada, the announcement of early successes with antiretroviral therapy (ART) prompted Brazil's legal response of guaranteeing the rights of universal access to such medication. In spite of this progress, most government agencies were still in denial about the severity and reluctance to respond to the growing need of the epidemic. The combination of civil domestic pressure, an increase of cases from zero to 10,000 between 1982 and 1990, and the international fear of a totally out of control epidemic by the year 2000, prompted the restructuring of the National AIDS Control

Program and, therefore, more substantial financial support (Levi et al 2002). Providing free ART to the seropositive population has been referred to as the key element for the stabilized rates of HIV/AIDS transmission seen today in Brazil (Parker 2009; Dourado 2006; Levi et al 2002).

2.1.1 Evolution of policy/approach: 1985-present

In addition to the new Brazilian constitution and the 1996 mandate assuring universal access to ARVs, the lack of laws recognizing industrial property rights until 1996 accelerated the ease with which the government produced and disseminated these pharmaceutical drugs (Ford et al 2007). Distribution of drugs, such as zidovudine (AZT) – the first AIDS medicine on the market approved by the Food and Drug Administration (FDA), started as early as 1991 coordinated by the National STD/ AIDS Programme that was established by the Ministry of Health (MoH) in 1986 (Greco & Simão 2007). In 1996, the passing of the World Trade Organization's Agreement on Trade-Related Aspects of Property Rights (TRIPS)[1] was detrimental to the Brazilian STD/ AIDS Programme because it instituted the 'pipeline mechanism'. The pipeline mechanism "provides retroactive patent protection for medicines not yet marketed in Brazil, but which have been granted protection elsewhere" (Fort et al 2007, S24)[2]. This resulted in the instantaneous blockade of five key antiretroviral drugs due to the granted patents (abacavir, efavirenz, lopinavir/ ritonavir, nelfinavir and amprenavir). The Brazilian government's intentions for implementing policies revolved around better managing the spread of HIV, extending the life expectancy of PLHIV while abiding by the Brazilian constitution in providing universal health care to its people, guaranteeing sustainability of

[1] Due to mounting pressure from the United States, Brazil passed an Industrial Property Law n9.279/96,
[2] As a result, Article 229c incorporated by Law 10196/2001 in its Intellectual Property legislation, known as 'Prior Consent' Amendment of 2001 was added. This allowed the Brazilian Regulatory Drug Authority and ANVISA to award prior consent to a pharmaceutical patent in Brazil.

this mandate through financial negotiations, and assuring compliance with the TRIPS Agreement. In concordance with these legislations, prevention strategies were also initiated as a means to educate the public and to bring awareness to this growing epidemic in Brazil.

Luckily, many of the intended goals were met. The total number of HIV/ AIDS cases in Brazil has stabilized at approximately 600,000 people, reflecting a prevalence of 0.61 that has remained constant since the year 2000 (Ford et al 2007; Greco & Simão 2007). Although the Northeastern region has been experiencing a trend of rising incidence rates for the past decade, these rates are still far below international estimations of a decade ago. Surveys and distribution of condoms are often used as a means to measure prevention tactics. In 2007, the government distributed one billion condoms at no out-of-pocket cost to recipients. A 2004 survey discovered that 96 percent of the population between the ages of 13 and 64 is aware that condom use is the best way to prevent HIV/ AIDS. It also reported an increase by 50 percent in condom use by young people during first intercourse experience; from 10% in 1986 to 60% in 2004 (Greco & Simão 2007). These numbers represent a positive consequence of what has become known as Brazil's HIV/ AIDS Model.

As mentioned earlier, the current policy has been in place for approximately 15 years and has been regarded as being extremely successful. Yet, the burden of such success is troublesome for the Brazilian government, especially in regards to the fiscal aspects of this policy. Today, 80 percent of the budget for the National STD/ AIDS Programme is spent on eleven patented medications that are essential for the ARTs (Ford et al 2007). Three of these newer drugs (Lopinavir/ritonavir, nelfinavir, and efavirenz) constituted over 60 percent of the Brazilian ART budget in 2003. Some may argue that fiscal issues could lend themselves to social costs, where: perhaps the seropositive

population is not cohesively being served due to lack of sufficient medication or perhaps, the growing budget is cutting into other necessary health programs that affect larger segments of the population (such as dengue fever).

Fortunately, all public hospitals and clinics are registered with Brazilian's Unified Health System (SUS - Sistema Unico de Saúde) and all ARVs are distributed according to the needs of a particular state or municipality[3] (Chaves et al 2008). But in order to achieve higher accessibility, further development and infrastructure would be necessary, particularly when managing the disease amongst the poor and the geographically marginalized. Perhaps more support for the existing administrative structures, such as the National STD/ AIDS Programme, MonitorAIDS and SUS could be implemented.

Through the universal ARTs access mandate, today almost 200,000 people receive ART in Brazil, with 17 drugs available through HAART (highly active anti-retroviral therapy). Currently 70,000 people are receiving follow-up assistance, but do not yet require ART or HAART. Between 1996 and 2004, the AIDS mortality was reduced by 50 percent, AIDS morbidity fell by 60 percent and AIDS related hospitalizations fell by 80 percent, saving the government over two billion U.S. dollars due to hospitalization and out-patient care (Ford et al 2007; Greco & Simão 2007). These cost-saving and additional benefits are said to be a direct reflection of proper decision making and policy implementation (Parker 2009).

Since Brazil is not considered a low-income country due to recent economic growth, it is excluded from receiving the cheapest prices available for ART in the international market. Middle income countries, such as Brazil and Thailand, find themselves in a double-bind, where prosperity and growth are posing a negative impact in

[3] Regulated under laws 8080/90 and 8142/90.

the negotiations for cheaper and more sustainable ARV prices, often paying up to four times more for some drugs than other nations (Ford et al 2007). Excluding the sustainability of and expenses due to ART, the geographical coverage of the dissemination of this policy must be questioned. The success of Brazil's model is not being discredited, but the lack of infrastructure, high illiteracy rates and extreme economic disparities lead to great barriers truly providing specialized health care and medication to all individuals who need it.

ART is being provided for free to the Brazilian population, but the government's power to address this pandemic is limited. Not only is the government's access to newer drugs imperfect due to increasing costs, but also increasing number of people requiring ART and the still present stigma and discrimination are major issues often outside the government's reign. New cases of HIV/ AIDS have stabilized in the country but approximately 20,000 new patients per year are requiring ART which further consumes the budget for ARVs in Brazil and expending the epidemic; especially in the Northeast.

2.2 THE BRAZILIAN SOCIAL & EPIDEMIOLOGICAL CONTEXT

Brazil is the fifth most populous country in the world, with approximately 190 million inhabitants. In 2010, Brazil had a Gross Domestic Product (GDP) per capita of roughly US$10,000 (US State Dept, 2011). The GDP alone does not reflect the profound social inequalities experienced in the country nor the deep regional disparities found within Brazil (Teixeira et al 2003). These inequalities are due in part, to lack of infrastructure, and to living conditions that have made large segments of the population vulnerable to HIV through extreme poverty, social exclusion and violence (Levi 2002). The United Nations' index of human development (HDI) has been beneficial in

correlating health, infrastructure and disease transmission, including increased HIV rates. In addition to the HDI, indicators of accessibility, such as distance to/from highways and railroads, were also found to be inversely associated with HIV/AIDS transmission (Hacker et al 2009). The HDI has consistently placed Brazil between 70th and 75th place, just above Bosnia and Herzegovina (UNDP 2009). Investment in local development and funding towards operational research regarding social, behavioral, epidemiological and clinical aspects of the AIDS epidemic in Brazil has been deemed pressing and essential (Greco & Simão 2007).

A contradiction exists regarding the discussion of accessible health care infrastructure and the access to free AIDS treatment in Brazil. Some researchers emphasize the success of an existing network of more than 1,200 public services that normally fits the needs of the region, although these services' infrastructure is highly variable (Teixeira et al 2004). Conversely, poverty issues become too significant to be ignored when, for example, lack of money for transportation hinders the patient's access to free medical care (Greco & Simão 2007) or when quality of health service is the main factor associated with inducing compliance from patients (Teixeira et al 2003). For instance, health-services that are classified as providing the ultimate quality of care have a 20 times higher rate of patient adherence to medical treatment than lower rated health services. This has been found to be true regardless of the mode of HIV transmission (Greco & Simão 2007; Nemes et al 2004). Further impeding the accessibility to AIDS treatment in Brazil is the growing seropositive population requiring ARV medication, which poses an ever growing financial burden on the State. Rising health care expenditure for HIV/AIDS services can translate to higher portions of the HIV-positive population unable to receive treatment or even substandard allocation of funds for primary medical services for the overall population.

In addition to the struggles related to HIV policies, coverage of actual distribution of drugs and stigma are also concerns. According to the AIDS Treatment for Life International Survey (ATLIS), the biggest fear of the HIV positive population is the fear of stigma and discrimination, so much so that 26 percent of participants had never started HIV treatment. In the same survey, of the eight thousand people interviewed in Brazil, over a fifth (22.5 percent) would not buy vegetables from a store where an HIV positive person worked, and 13 percent affirmed that a seropositive teacher cannot teach in all schools. Statistics such as these translate into action and force many PLHIV in Brazil to hide their seropositive status for fear of losing their job, their partners, the support of their family or children, and for the fear of being ostracized by the community. Even though Brazil has been one of the countries that has managed to minimize HIV-related stigma and discrimination (AVERT 2010), it also has a history of HIV-related hate crimes, including murder.

Inter-Governmental Organizations and many national governments have applauded the Brazilian response to HIV/AIDS and commended the country's dedication to fighting stigma and discrimination. This reflects the multiple legislations that the Brazilian government has passed which address universal health care treatment for PLHIV and HIV/AIDS rights in the work place, such as the criminalization of homophobic acts with the bill no. 5.003/01 (PAHO 2008). But creating a law does not translate into modified social actions; especially when the intervention is not addressing the root cause of the problem. During the initial years of the HIV epidemic in Brazil, 76 percent of reported cases came from homosexual and bisexual men, and although this number dropped to 24 percent in the year 2000 (Kerr-Pontes et al 1999) stigma of HIV is still highly associated with male homosexuality. Some experts consider Latin America to be one of the regions with the highest number of crimes against homosexuals (Mott

2005), with Brazil topping the list. It has also been estimated that every three days, one homosexual is murdered in Brazil (PAHO 2008; Mott 2005; Mott & Cerqueira 2001). Statistics from the Grupo Gay da Bahia (Bahia's Gay Advocacy Group) show that 2,511 people were murdered in homophobic crimes between 1980 and 2005, and posters line the streets with the slogan "Keep Bahia Clean: kill a queer today" supported by one or more of the twelve anti-gay extermination groups in the country (PAHO 2008; ICCHRLA 1996). In addition to murder statistics, discourses occurring on online networks, such as You Tube, reflect the still present stigma in Brazil. Comments such as, "Homosexual today, HIV-positive tomorrow" and "the worst disease of all [that of being a homosexual] is being overcome by AIDS", subsequently get transferred to PLHIV as the notion of 'AIDS as a gay disease' persists (Deacon et al 2005; Sayce 2003).

Similarly, informing or educating people does not necessarily change their attitudes, or their behavior (Deacon et al 2005; Sayce 2003). In a 2001 study encompassing seven cities in Brazil, it was found that although gay men were very well informed about prevention methods and condom use, the information did not directly change their behavior, especially among young gay men which used condom less frequently than their older counter parts. Although these behaviors (or lack thereof) could be a result of a multitude of things, it is definitely influenced the methodology behind the interventions. Recent campaigns (beginning in 2002) moved away from the dominant communication model, which emphasized individual behavior change, and towards campaigns focused on social change (PAHO 2008). The prior model that isolated individual behavior was deemed ineffective towards the HIV epidemic in Latin America (Airhihenbuwa et al 2000), for it did not incorporate the political, social, and socioeconomic factors that increase one's vulnerability to the virus.

Currently, the HIV pandemic in the South of Brazil has been assessed through spatial frameworks (even so, only lightly) (Hacker et al 2009) and geographical studies have been deemed essential in gaining a broad picture of the Brazilian situation**.** The case of Fortaleza in the Brazilian Northeastern state of Ceará demonstrates how the confluences of social and epidemiological factors influence the spatial distribution of HIV.

Cumulative Population of Brazilian (2000)	*~172 million*
Cumulative AIDS Cases (2002)	237, 588
Cumulative AIDS Deaths (2002)	110, 651
Estimated Number of HIV+ Individuals (2000)	597, 000
Incidence Rate of AIDS (2000)	12.4/ 100,000
Prevalence Rate of HIV (2000)	0.6%

Table 2.1: Epidemic Profile of Brazil

2.3 LOCAL CONTEXT - FORTALEZA:

Fortaleza, known as the *Land of the Sun* and *The Capital of Excitement*, was estimated to have a total population of over 2.5 million in 2009 becoming the fifth most populous city in Brazil and the most populated city in the Northeast (IBGE 2000). Fortaleza also holds the title of most densely inhabited city in Brazil; with approximately seven thousand people per square kilometer (IBGE 2009; Araújo et al 2003). Although Fortaleza has been deemed the municipality with the seventh highest purchasing power in the nation, approximately one-third of its population lives in one of the cities' more than

700 *favelas* (ghettos). Such disparity is a product of historical developmental strategies differing in the more industrialized South and the undeveloped Northeast. During the past few decades, growing industrial investment has allowed Fortaleza to grow at a faster pace than other major cities in the Northeast (Recife & Salvador) and has spurred an influx of migration to Fortaleza, especially from its rural surroundings (Araújo et al 2003).

According to Araújo et al (2003) what differentiates Fortaleza from other metropolises are the arrangement of group clusters, their power relations/ interactions and how these social segments are positioned in space. Historically there has been a myth or belief that the city of Fortaleza was divided economically by the major highway (BR-116), with a rich East and a poor West. Poverty and inequality in Fortaleza have been traditionally described and understood at the scale of the barrio, some representing historical and financial opulence, and others known to reflect migration and misery. And although stark economic disparity has been shown to accentuate health disparities and vulnerability to HIV transmission, what Araújo et al (2003) argue is that the economic inequality in Fortaleza is not spatially as segregated as previously thought. The article describes that within known affluent barrios, large pockets of extreme poverty are very present and vice-versa. These pockets of differing socio-economic statuses may reflect factors influencing HIV transmission. It also imposes increasing difficulty in properly addressing socio-economic factors in the poorest sectors due to the lack of geographically defined communities. Such sharp differences in small areas may also lower community cohesion, social capital and individual support systems, all of which heighten the probability of HIV infection.

According to the news article in the Northeast Newspaper (Diário de Nordeste 09/12/2006), the Municipal Health Ministry announced that everyday two AIDS cases are identified in Fortaleza. Between the years of 2000 and 2007, Fortaleza experienced a 54

percent increase in total number of HIV/AIDS cases (Guimarães 2007; De Lisser 2001). In this Northeastern city, intravenous drug users (IDUs) are not representative of the HIV epidemic, instead sexual relations (homosexual, bisexual, and heterosexual) account for the transmission method of most HIV cases; 72.7 percent (Gonçalves et al 2008). Research has shown that AIDS cases amongst heterosexuals present a more diffuse geographical pattern when compared to IDU cases. Fortaleza hosts the only hospital for infectious diseases (Hospital São José) for entire state of Ceará, providing much of the specialized health services from one central point, currently overwhelmed by the demand of the HIV/AIDS positive community (approximately 5,000 people). Therefore, the hospital is not only overburdened, but it also illustrates the lack of accessibility to these specialized services for the underprivileged. As a result of hindered accessibility and heightened illiteracy for large segments of the population, the Ministry of Health (MoH) has created many television campaigns and visually oriented ads for a more inclusive prevention tactic. The efforts of the MoH in television campaigns have been admirable and can be considered a success considering that 80 percent of the population owned televisions in Brazil in the year 2000; according to the Inter-American Development Bank (Chong & Ferrara 2009). But not all groups are benefiting equally. HIV/ AIDS is following the poverty trend in the country impacting the interior and poor communities, who are less prepared to seek medical needs due to inability to read/write and lack of financial stability.

Cumulative Population of Fortaleza (2000)	*2,141,402*
Cumulative AIDS Cases (2006) [2009]	4,605 [7,985]
Estimated Number of New HIV+ Individuals (2000)	335
Incidence Rate of AIDS (2000)	14,7/ 100,000

Table 2.2: Epidemic Profile of Fortaleza

Chapter 3: Methodology

Spatial analytical techniques were applied in this study in an attempt to answer the following questions;

- What is the spatial distribution of HIV/ AIDS in Fortaleza? ;
- Where are clusters of low rates (cold spots) or high rates (hot spots)? ;
- Using a marginalization index, which areas are most marginalized? ;
- How is the HIV distribution correlated to one's socio-economic and socio-demographic status (marginalization)? ; and
- Which marginalization variables are correlated with HIV cases?

3.1 Study Area; Fortaleza, Ceará

As discussed in earlier chapters, the Brazilian Northeast displays rising HIV incidence, differing from HIV in rest of the nation where HIV incidence appears to have stabilized. Representative of a Northeastern urban core, for contains a large population (2.2 million) which sufficiently shows socio-economic disparities and it is expansive enough to also depict these disparities spatially, Fortaleza was chosen as the study area of this research.

Fortaleza stands as the fifth largest city in Brazil, just three degrees below the Equatorial line (refer to Figure 3.1). This city has 34km of coastline, with an area of 313km^2 and lies at 21 meters above sea level. The topography of Fortaleza consists of marsh land, including the 1,155 hectors that constitutes the Cocó Ecological Park which lies in the east-central part of the city. This ecological area could pose as vital points of further exploration as it houses many marginalized sectors of society; also traditionally residing near rivers, lagoons, and sand dunes that form throughout the city. Fortaleza consists of six regional boundaries called, 'Executive Regional Secretariats' (SERs -

Secretarias Executivas Regionais), and recognizes 114 barrios (refer to Figure 3.2); within which more than 700 favelas have emerged. Although the favelas should not be viewed as physical barriers to health access, the lack of infrastructure, such as basic sanitation and sewage systems, could impede the access to health care for those living in this environment. The data will represent the new cases of HIV in Fortaleza and socio-demographic information for the year 2000. Individuals with HIV found to be living outside the municipal city limits will be excluded from this study.

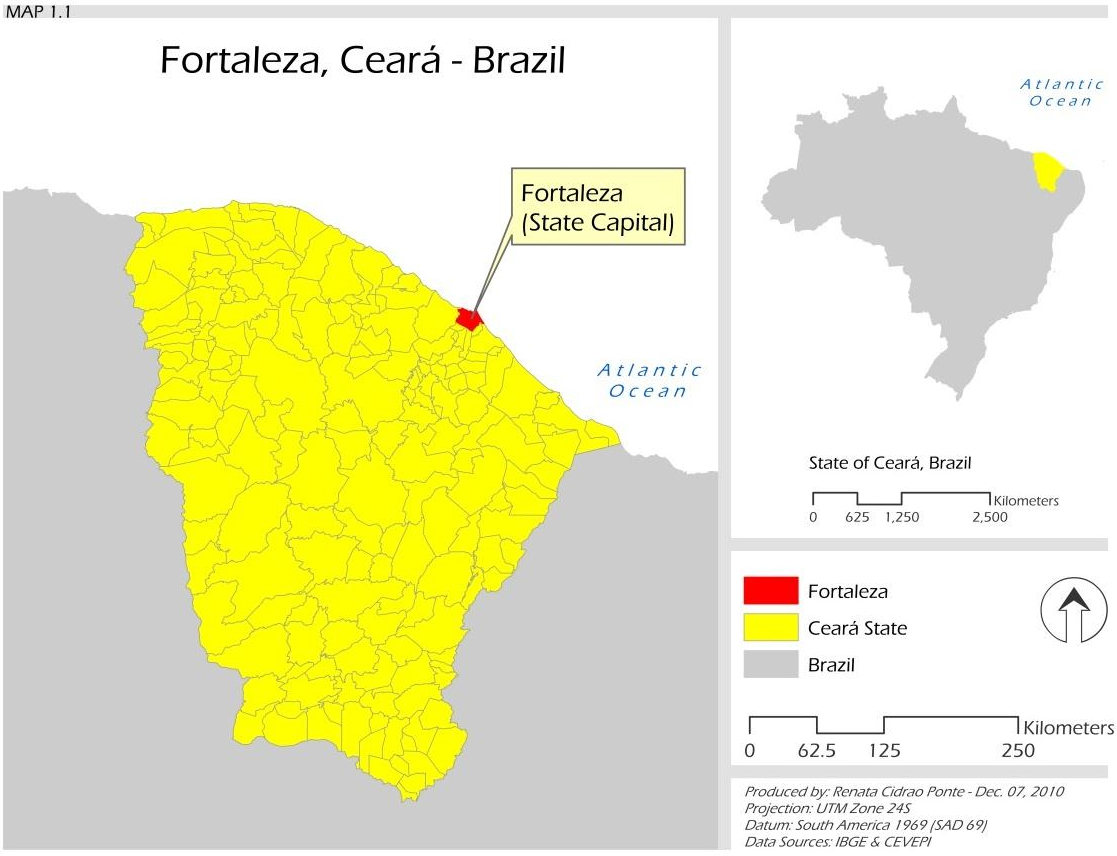

Figure 3.1: Reference map of Ceará State, with its capital, Fortaleza, Brazil

Analyzing the spatial distribution of communicable diseases can seem straight-forward when compared to spatial patterns of sexually transmitted diseases, particularly, HIV/ AIDS. Other than the multitude of variables and vectors present, one must also take into consideration the social/ cultural structure of the study area and the stigma and discrimination that accompanies and hinders many people living with HIV/ AIDS, especially in developing nations. Due to the complexity of HIV research in social sciences, it is not generally accepted to announce direct correlation between marginalized populations and vulnerability to HIV acquisition. Nonetheless, through this research an argument is created stating that although there are many other factors influencing one's risk for becoming seropositive, using a marginalization index similar to the one created by the Mexican government would allow for some insight into the health situation in urban centers.

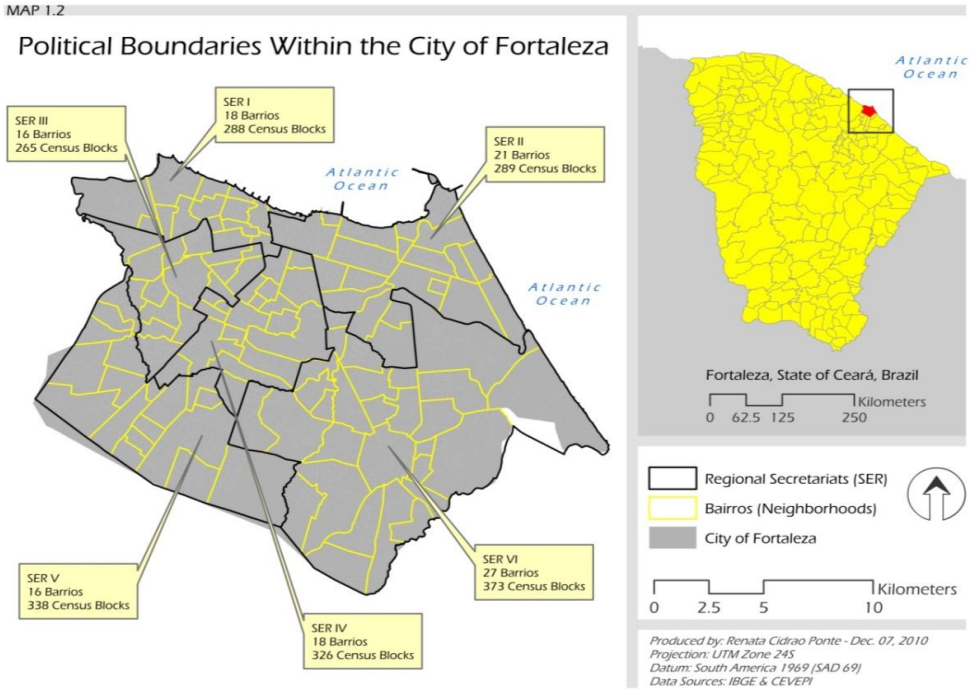

Figure 3.2: Political boundaries within the city of Fortaleza: SERs, barrios, and census tracts.

3.2 DATA

This project draws from the current literature concerning health geography, as well as literature that address issues of development, urban sprawl, socio-economic disparities, and HIV/ AIDS (Peters et al 2008; Barnett & Whiteside 2006; Araújo et al 2003; Teixeira et al 2003; Seal et al 2002). Some public policy briefs and reviews also inform the research on how to present information in a manner which will serve the public policy avenues and the academic sphere. All the data required were obtained during field research in the summer of 2010 in Fortaleza, Brazil after the proper permission of the Institutional Review Board (IRB) in the United States and the 'Ethics Committee' in Fortaleza. The most current data available for both demographic variations and HIV incidence was for the year 2000, thus this study utilizes 2000 data for all its analyses.

3.2.1 Health Data Collection

Fortaleza, as many Northeastern cities in Brazil, suffers from the burden of various infectious diseases, such as dengue fever, tuberculosis and schistosomiasis. As previously mentioned, HIV/ AIDS received the proper public health attention and the management of the disease was deemed highly successful; until recently when trends were again rising in the Northeast region. Data pertaining to new cases of HIV in Fortaleza and the geographic locations of said cases were made available for this research through the Center of Epidemiological Vigilance within the Municipal Health Secretariat (CEVEPI). The CEVEPI office gathers and stores data of most ailments in Fortaleza, creating epidemiological newsletters, informing hospitals and public health officials, and educating the public. For this, CEVEPI has geo-referenced, point data regarding all cases of HIV in Fortaleza. Although access to CEVEPI's point dataset was not granted for this project (due to privacy issues), agglomerates of data were created based on census blocks

polygons. According to Drewnowski et al, (2007) it is optimal to map disease rates at a coarser scale, such as by community or neighborhood, for it is the direction in which public health assessment and surveillance is moving towards. In compliance with IRB specifications, all personal identifiers were excluded from the data (i.e. name, address, phone number, and gender). Therefore a dataset of new cases of HIV at the census block level with no personal identifiers was used to perform the spatial analyses.

3.2.2 Socio-economic data

The 2000 census data from the Brazilian Institute of Geography and Statistics (IBGE) were used to represent socio-demographic and economic variations in the city of Fortaleza. The scale used to display census data is the census block, thus allowing for a direct comparison to the HIV data gathered. Although a Gini coefficient is often used as a measure of inequality it is calculated for the entire municipality and not at a finer scale, such as barrios or census blocks, therefore a marginalization index was created for Fortaleza since one did not already exist. A widely used deprivation index for ecological analysis of health, known as the Townsend index (Lorant et al 2001; Bithell et al 1995), was not feasible due to missing data, such as overcrowding, and care ownership data, which is incorporated into the Townsend index and not included in the Census 2000 data. Instead, the marginalization index created by the Mexican Government Branch of Population Studies (CONAPO) was used as a template for the creation of Fortaleza's marginalization index (MI). CONAPO's index was chosen not only because it was deemed feasible with the census data available, but also because it was more appropriate to use for this study area due to similarities in the two nations' demography, development, and economy. A precise explanation of the creation of this index can be found in the methods section (3.3.2) bellow.

3.3 METHODS

The methods of analyses for this study were chosen to highlight the relationship between HIV incidence and the variables of marginalization in an effort to better comprehend the relationship between poverty and HIV in Northern Brazil.

3.3.1 Spatial analyses

This study utilized the Moran's *I* statistic and the Getis-Ord General G to measure the global spatial autocorrelation of HIV and marginalization in the city of Fortaleza. Moran's I was used as a measure of spatial autocorrelation to identify the degree of spatial clustering of new cases of HIV. Moran's I coefficient is defined as (Cliff & Ord 1981):

$$I = \left(\frac{1}{s^2}\right) \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_i - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \quad (1)$$

where:

$$s^2 = \frac{1}{N}\sum_{i=1}^{n}(x_i - \bar{x})^2 \quad (2)$$

where n is the number of spatial units (census blocks, n=2240), x_i and x_j are the values of the variables of interest in the census blocks (HIV and MI), and w_{ij} is the spatial weights matrix corresponding to the observation pairs of the census *i, j*, since *i* refers to a particular census block and *j* refers to that census block's neighbors. This study defined neighbor relationships by using a first order queen contiguity spatial weights matrix, in

which census block *i* is considered neighbor of census block *j* if they share a common boundary and the spatial weights matrix was row standardized. The Moran's *I* coefficient varies from -1 to +1, where the larger the value of *I*, the stronger the spatial autocorrelation.

In order to complement the Moran's *I*, the Getis-Ord General *G* index was utilized because it enhances the results of Moran's *I* by identifying spatial concentrations of hot and cold spots (i.e. high-high and low-low clusters; also described as H-H and L-L). Based on the same factors as the Moran's *I,* the Getis-Ord G was calculated as follows (Getis & Ord 1992):

$$G(d) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}(d)x_i x_j}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j}\ , \forall j \neq i \tag{3}$$

Source of infection, mode of transmission, population characteristics, and behavioral distinctions often impacts an individual's safe sex practice, causing the HIV cases to vary geographically throughout a study area, and therefore census blocks may not always exhibit similar features as its neighbors (Peng et al 2011). LISA is the most commonly applied statistic for the purpose of distinguishing how spatial correlation varies within a study area. Anselin's LISA was used in this study to analyze local patterns of clustering in potential risk factors of HIV (Chaves et al 2008), and is defined as (Anselin 1995):

$$I_i = \frac{(x_i - \bar{x})}{s^2} * \sum_j w_{i,j}\,(x_j - \bar{x}) \tag{4}$$

A local adaptation of Moran's *I (Ii)*, LISA compares the value of the variable of interest (HIV or MI) in a given census block with those in neighboring census blocks.

3.3.2 Marginalization index

As mentioned in the previous chapters, merely utilizing earned income as a proxy for deprivation in a community has not been deemed adequate in HIV studies. One of the main reasons for this is that earned income alone does not reflect the inequalities found within the community and is not reflective of the marginalization of certain populations in Fortaleza. Marginalization is defined in this study as "the lack or limited access to resources that ensure a satisfactory quality of life" (Chaves et al 2008, 177), thus posing adverse effects on health. Therefore, this study created a deprivation index based on CONAPO's marginalization index. CONAPO's index was chosen due to similarities in cultural, developmental and economical aspects between Mexico and Brazil, as well as due to data availability. Using CONAPO's methodology and IBGE's Census 2000 demographic information, nine variables were identified as a proxy of marginalized populations (CONAPO & IBGE). The variables are as follows; (1) illiteracy, (2) education level, (3) improvised housing, (4) lack of toilet/ sewage, (5) erroneous trash disposal, (6) lack of piped water, (7) unemployment, (8) minimum wage, and (9) house ownership/rental/ neither. With equally weighted variables, the marginalization index (MI) was calculated, thus representing the level of marginalization of each census block in Fortaleza. This marginalization index serves as a "robust measure of social outcast status since it is constructed using several variables associated with social exclusion, including income, literacy, level of education," etc. (Chaves et al 2008, 177). Below are definitions and calculations of the nine variables, all based on CONAPO's methodology and IBGE's data and definitions.

3.3.2.1 Literacy/ Illiteracy

The first variable which comprises the MI created for this research is rate of illiteracy. Illiteracy was calculated as the percent of the population over the age of fifteen that are cannot read or write (PPA).

$$PPA = \frac{P^{analf}}{P^{15>}} * 100 \tag{5}$$

where $P^{15>}$ is the total population 15 years of age and older, and P^{analf} is population 15 years of age and older that is illiterate.

3.3.2.2 Education Level

Minimum education levels represent the second variable of the MI. It is symbolized as the percent of population over the age of fifteen that only completed primary school (PPE). Primary school (*primaria*) in this case stands for alphabetization (year prior to first grade where one learns to read and write in Brazil) plus grades 1 through 4. One caveat of this data is that it is only available for heads of households (IBGE 2000). The representation of minimum education levels were calculated as such:

$$PPE = \frac{P^{sem} + PP^{<5}}{P^{15>} - NE^{notd}} * 100 \tag{6}$$

where P^{sem} stands for the population age fifteen and over that has had no schooling, $PP^{<5}$ is the population age fifteen and over that has had five years of schooling (first year is the alphabetization in plus grades first through fourth), $P^{15>}$ is total population fifteen years of age and older, and NE^{notd} is the population (head of household) fifteen years of age and older with education level not determined.

3.3.2.3 Improvised Housing

The percent of population that live in improvised housing was the third variable in the marginalization index (PPH). A 'house' was considered improvised by IBGE (2002) if it was located in a store or industry, located in a non-residential building, and/or located in a building still under construction. Also, railcars, stores, 'shacks', caves or a cart on wheels, that were being used for housing were also considered improvised housing. It is important to note that the methodology for CONAPO used data for homes that did not have adequate floors (such as those living on dirt floors), but the IBGE census did not have such a category; therefore improvised homes were used in replacement.

$$PPH = \frac{I^h}{P^h} * 100 \tag{7}$$

where I^h represents the total population living in improvised homes, and P^h is the total population in homes/ residences.

3.3.2.4 Lack of Sanitation/ Sewage

The percent of population that have neither bathrooms (toilets) nor a sewage system (PPO) formed the fourth variable in the MI. According to the CONAPO methodology, 3 calculations are necessary to determine PPO. The first calculation is related to the percent of the population that does not have a bathroom in their living space (PO^b). A bathroom was considered anything with a shower or bathtub and a toilet. A toilet was considered any space delimited or separated by any type of material (independent of having a roof or not) that had either a toilet or a hole for human

excretion. This variable only considered the population that had neither a bathroom nor a toilet.

$$PO^b = \frac{O^b}{P^o} * 100 \tag{8}$$

where O^b is the total population in housing with no bathroom nor toilet and P^o is the total population in housing. The next calculation refers to the percent of population with inadequate/ no sewage/ septic system (PO^e). The sewage/ septic system were defined as the type of sewage directly connected to the toilet. The variables considered as lacking a sewage system were: rudimentary sewage (homemade septic tank/well with no finishing and where excretions are in direct contact with the soil/land), open air hole (where piping could be placed but has not), and river, lake or ocean (where toilet was directly connected to these water bodies), among others. Lacking sewage was only measured with residences that had bathrooms or toilets, therefore in order to discover the population without sewage, the following was calculated. This percentage essentially shows all residents that have bathrooms/ toilets but have no sewage (PO^e).

$$PO^e = \frac{B^{oe}}{B} * 100 \tag{9}$$

where B^{oe} is the total population with bathrooms/ toilets and no sewage and B is the total population with bathrooms. Therefore the calculation to determine the percent of population that have no bathroom and no sewage/ septic system (PPO) was the following:

$$PPO = \frac{PO^e + O^b}{P^o} * 100$$

(10)

where PO^e is percent of population with inadequate/ no sewage, O^b is the total population in housing with no bathroom nor toilet and P^o is the total population in housing (following the same definition of variables above).

3.3.2.5 Trash Disposal

This fifth variable refers to the percent of population that disposed of trash inappropriately (PPL). Erroneous trash disposal was considered all types of trash disposal outside of the city trash pick-up system. That included, trash burned on property or site, buried on property or site, thrown in an empty or abandon lot, thrown into a body of water, such as a river, lake or ocean, and other; when trash was disposed of in another manner than those mentioned above. CONAPO's marginalization index did not use trash disposal as one of the variable included in the index. Instead, access to electricity was used. Due to limitation in the IBGE's data set, this project could not incorporate access to electricity. This substitution was done based on publications which analyze economic disparity in Fortaleza, and where trash disposal is seen as an important factor of economic and social disparity and therefore was used in replacement of the electricity use seen in the Mexican marginalization index (Araújo & Carleial 2003, Bento & Carleial 2010).

$$PPL = \frac{L^o}{P^o} * 100$$

(11)

where L^o is the population with erroneous trash disposal and P^o is the total population in housing.

3.3.2.6 Water Access

Water accessibility is considered the sixth variable of the MI, and it measures the percent of population that does not have access to piped water inside the home. The IBGE (2000) variables distinguished between piped water onto the property and into the home. This variable considered the entire population that had no piped water directly inside the home (PPW).

$$PPW = \frac{A^s}{P^o} * 100 \tag{12}$$

where A^s is the total population without piped water, and P^o is the total population in housing.

3.3.2.7 Unemployment

Also comprising the MI, is the rate of unemployment. The percent of head of households that had no income (unemployed) was calculated and represented as PPI. The IGBE census (2000) only determined unemployment rates for heads of households, but included any head of household above the age of ten. (note that the methodology for CONAPO only included the heads of household above the age of 12).

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$$PPI = \frac{N^i}{P^i} * 100 \tag{13}$$

where N^i is the total population without income, and P^i represents the total population head of household.

3.3.2.8 Minimum Wage

The minimum wage variable represents the percent of head of households that earn 2 minimum wages or less (PPM). As mentioned in variable number 7, heads of

households were considered of age ten and above. A minimum wage refers to a minimum monthly salary that employers are obliged to pay if an employee works full-time. The minimum wage in Brazil in the year 2000 (date of census) was R$ 155.00 per month (Brazilian Reais). Based on the US dollar exchange rate for the year 2000, the equivalent of two minimum wages was equal to $151.00 per month (US dollars).

$$PPM = \frac{M^i}{P^i} * 100 \tag{14}$$

where M^i is the total population earning 2 minimum wages (income), and P^i is the total population head of household.

3.3.2.9 Home Ownership

The percent of the population that lived neither in owned nor rented homes ($PPNH$), represents the ninth variable in the MI. If one neither owned, was in the process of buying (such as paying a mortgage), nor renting the property in which one was living, then he/she was included in this variable. Those that remained included were residences where the employer allowed employee to live there, or where the employer paid the rent for the residence; residences that were open freely for one to live in (excluding institutions), or others (such as where one lived inside the place of work, in a back room or attic or basement, or in an abandon building or land). It important to note that home ownership was not included in s a variable in CONAPO's marginalization index. Since the Mexican index was created for the entire nation, CONAPO used population in the city or village as a variable, accentuating all those that lived in an area with less than 5000 inhabitants. When calculating Fortaleza's Marginalization Index, this cut-off point

seemed indifferent since all census blocks were below that population cut-off. Therefore, this study included this variable as representative of economic and social marginalization.

$$PPNH = \frac{NH}{P^o} * 100 \tag{15}$$

where NH represents the total population living in homes neither owned nor rented, and P^o is the total population in housing.

3.3.2.10 Calculation of Marginalization Index

In order for all of the variables to have equal weight, a simple average was taken of all variables, v_n (v1 through v9) in the calculation of the marginalization index MI, as shown below.

$$MI = \frac{\sum v_n}{v_n}$$

OR

$$MI = \frac{PPA + PPE + PPH + PPO + PPL + PPW + PPI + PPM + PPNH}{9} \tag{16}$$

Referring back to the questions posed in the beginning of this chapter, one of the goals of this study is to discover which areas are most marginalized in Fortaleza. Similar to the process applied to the HIV incidence data, spatial analyses were utilized to discover if spatial autocorrelation exists among the marginalized population and what is the geographical distribution of these clusters found in Fortaleza. Furthermore, the

correlation between marginalization and HIV incidence was found through the use of a classical ordinary least squares (OLS).

3.3.3 Ordinary Least Squares (OLS)

This study hypothesizes that HIV incidence is positively correlated with rates of marginalization, and OLS regression was used to demonstrate the degree to which marginalization (and its variables) promotes negative or positive change in HIV incidence in Fortaleza. HIV incidence per population was the dependent variable while the nine separate components of the marginalization index were the explanatory variables.

The next section of this study highlights the results of the spatial analyses presented above.

Chapter 4: Results

4.1 Spatial Patterns of HIV Incidence for the Year 2000

Below is the geographical variation of HIV incidence in Fortaleza. In the year 2000, Fortaleza recorded 335 new cases of HIV. One of these cases occurred outside Fortaleza's revised city limits and therefore it was excluded from this research, leaving 334 new cases of HIV. The HIV distribution is expansive throughout the study area, although there is a slight noticeable concentration on the Western and Northwestern sections of the city. This slight tendency could be a reflection of population density. As displayed in figure 4.2, the population distribution in the city of Fortaleza is generalized but the population density is concentrated in the city's West and Northwest areas.

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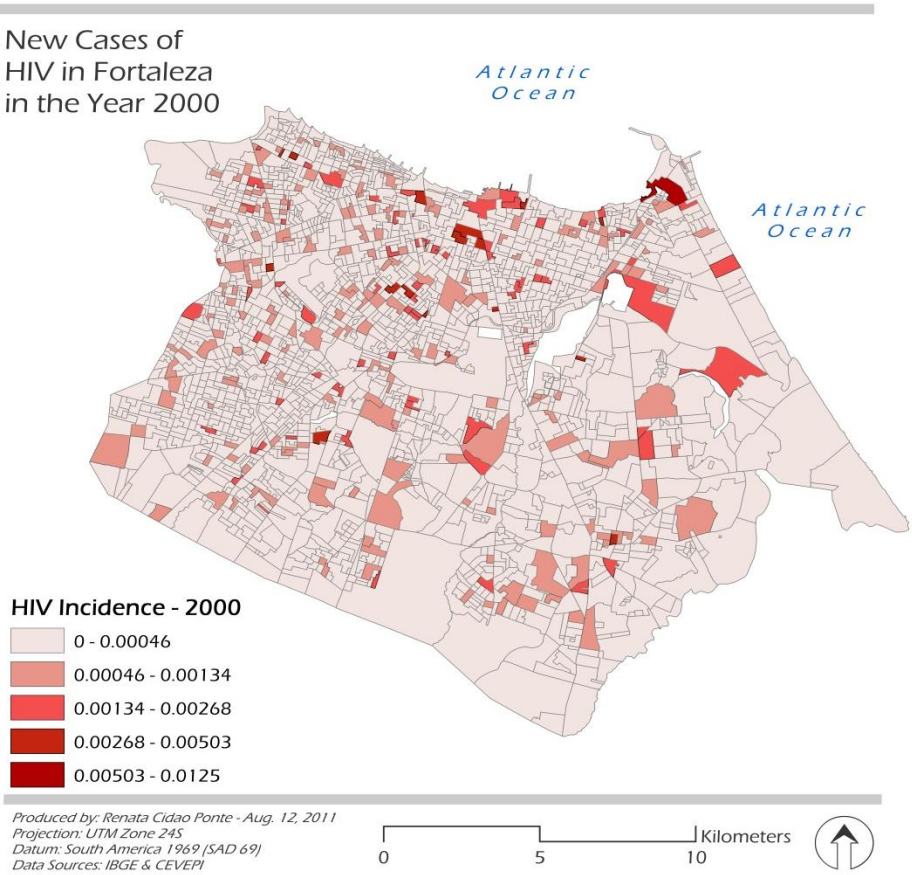

Figure 4.1: Incidence HIV in Fortaleza in 2000

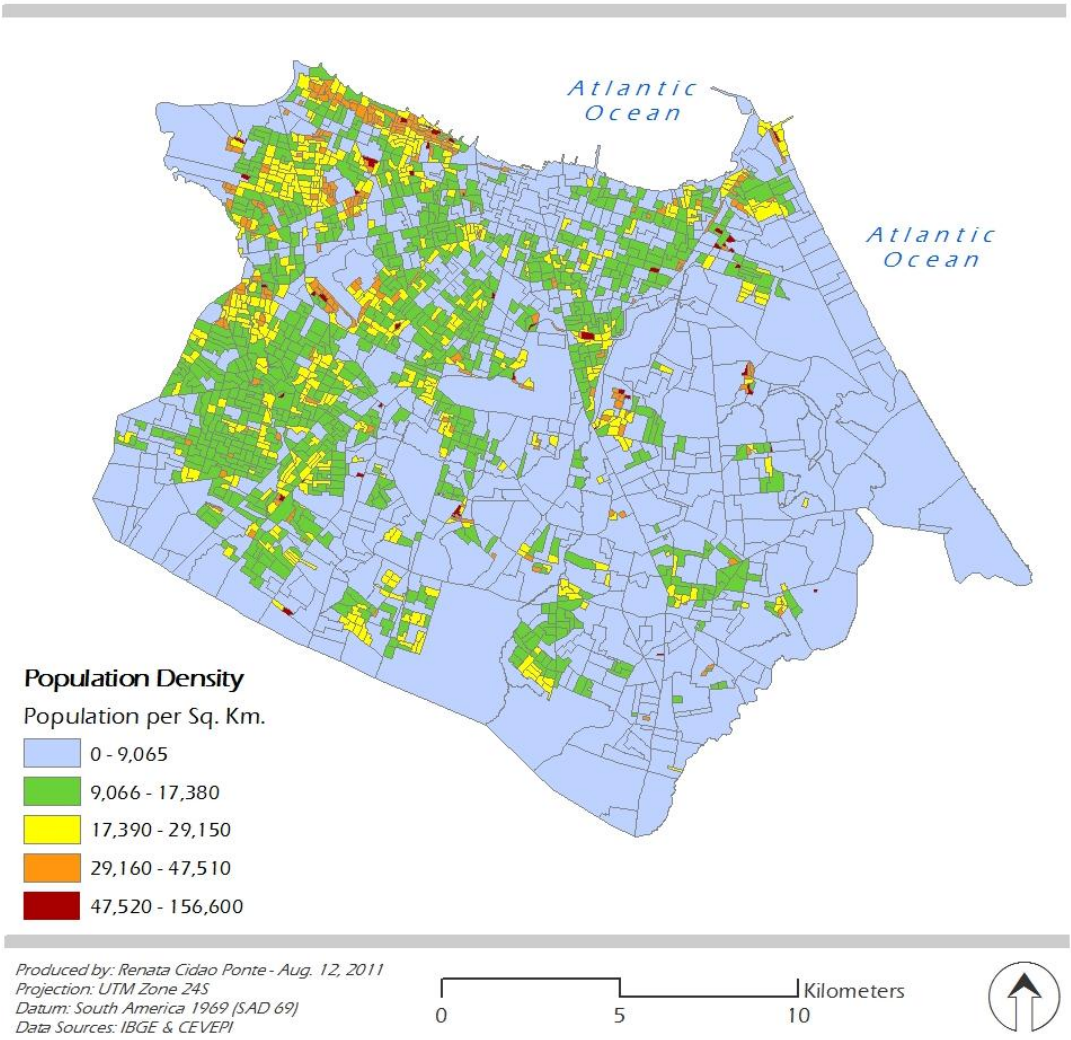

Figure 4.2: Population Density of Fortaleza per Sq. Km.

As mentioned previously, Fortaleza's population of approximately 2.2 million live in an extremely dense environment, with an average of 980 residents per census block and 6, 547 inhabitants per square kilometer. Of the 2.2 million people in Fortaleza in 2000, there are seven percent more females than males. In order to further analyze the socio-demographic characteristics and their spatial distribution, a marginalization index was created. The next section of this chapter will further explain and display the results of this index.

4.2 MARGINALIZATION VARIABLES ASSOCIATED WITH HIV INCIDENCE IN FORTALEZA

The marginalization index is compromised of nine variables equally weighted; (1) illiteracy, (2) minimal education level, (3) improvised housing, (4) lack of sanitation/ sewage, (5) erroneous trash disposal, (6) water access, (7) unemployment, (8) minimum wage, and (9) home ownership. The spatial distribution of each of these variables depicted a peripheral pattern, where the historical downtown in the North-central section of the city displayed lower levels of marginalization, and the census tracts in the periphery of the city housed the higher results.

According to the 2000 Brazilian Census data, an average of 7 percent of Fortaleza's population does not have access to running water and another 3 percent does not have any type of toilet or sanitation. In addition, 11 percent of the population is illiterate and 16.5 percent has only obtained a fourth grade education, further imposing difficulties in the creation of HIV-specific programs that reach that particular demographic. Furthermore, 10 percent of the population experienced unemployment and over 50 percent of the employed in the year 2000, received less than the minimum wage of $151 per month. For instance, out of all heads of households making below the poverty line (minimum wage) in Fortaleza, 49 percent are men whereas 66 percent are women. Women also outweigh the men in unemployment, where 13 percent of female heads of households are unemployed and only 8 percent of males find themselves in a similar situation. Such data paint a picture of the Brazilian poor, where women are hardest hit; especially in the rural areas. HIV is following the poverty trend in the country impacting the interior and underprivileged communities. This results in women

representing more vulnerability to this pandemic and often, they are less prepared to seek medical needs due to inability to read/write and lack of financial stability.

Table 4.1: Results of Marginalization Index Variables

Marginalization Index Variables	Total Population	Males	Females
1. Illiteracy	11.2%	11.62%	10.86%
2. Minimal Education Level	16.57%	*	*
3. Improvised Housing	0.31%	0.17%	0.13%
4. Lack of Sanitation/ Sewage	2.94%	*	*
5. Trash Disposal	4.77%	*	*
6. Water Access	6.93%	*	*
7. Unemployment	9.95%	5.56% (8.38%)**	4.38% (12.94%)**
8. Minimum Wage	55.08%	33.04% (49.36%)**	22.04% (66.46%)**
9. Home Ownership	6.17%	3% (6.35%)**	3.18% (6.02%)**
Marginalization Index	**12.68%**	*	*

**data not available* ***head of household*

The figures below depict the geographical distribution of each of the variables which comprise the Marginalization Index, ending with the spatial distribution of the index itself. It is also important to point out the north-south pattern along the lower

southwestern section which appears in some of the figures bellow. This pattern follows the Maranguapinho River, a known region for lower-income residents within the city.

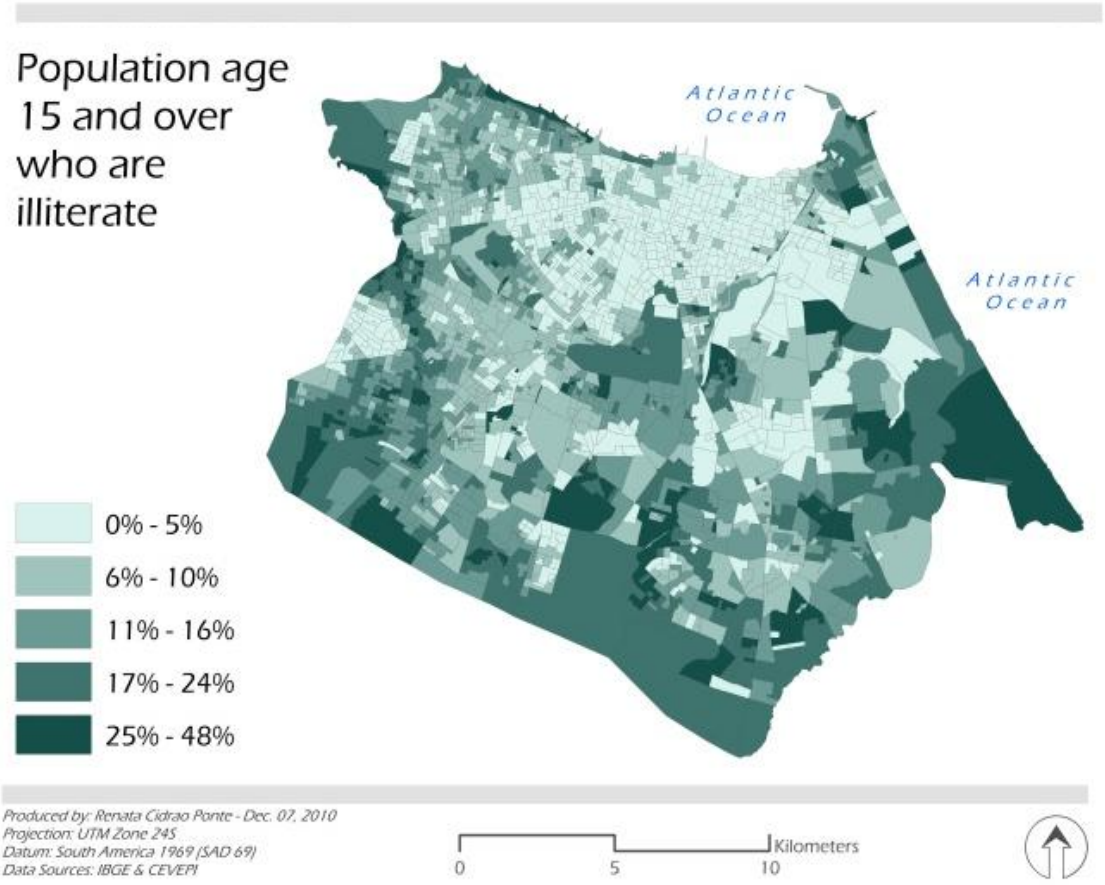

Figure 4.3: Population age 15 and over who are illiterate (variable 1)

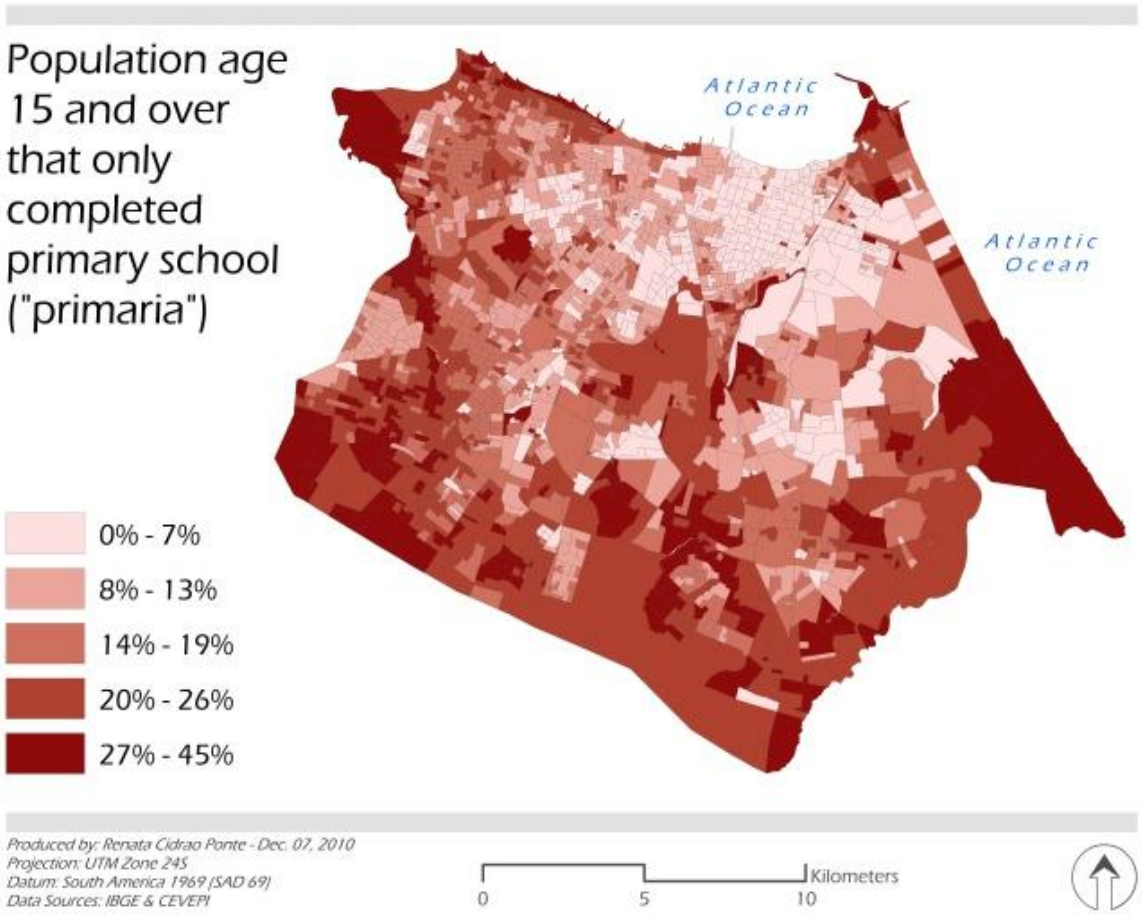

Figure 4.4: Population age 15 and over that only completed primary school (variable 2)

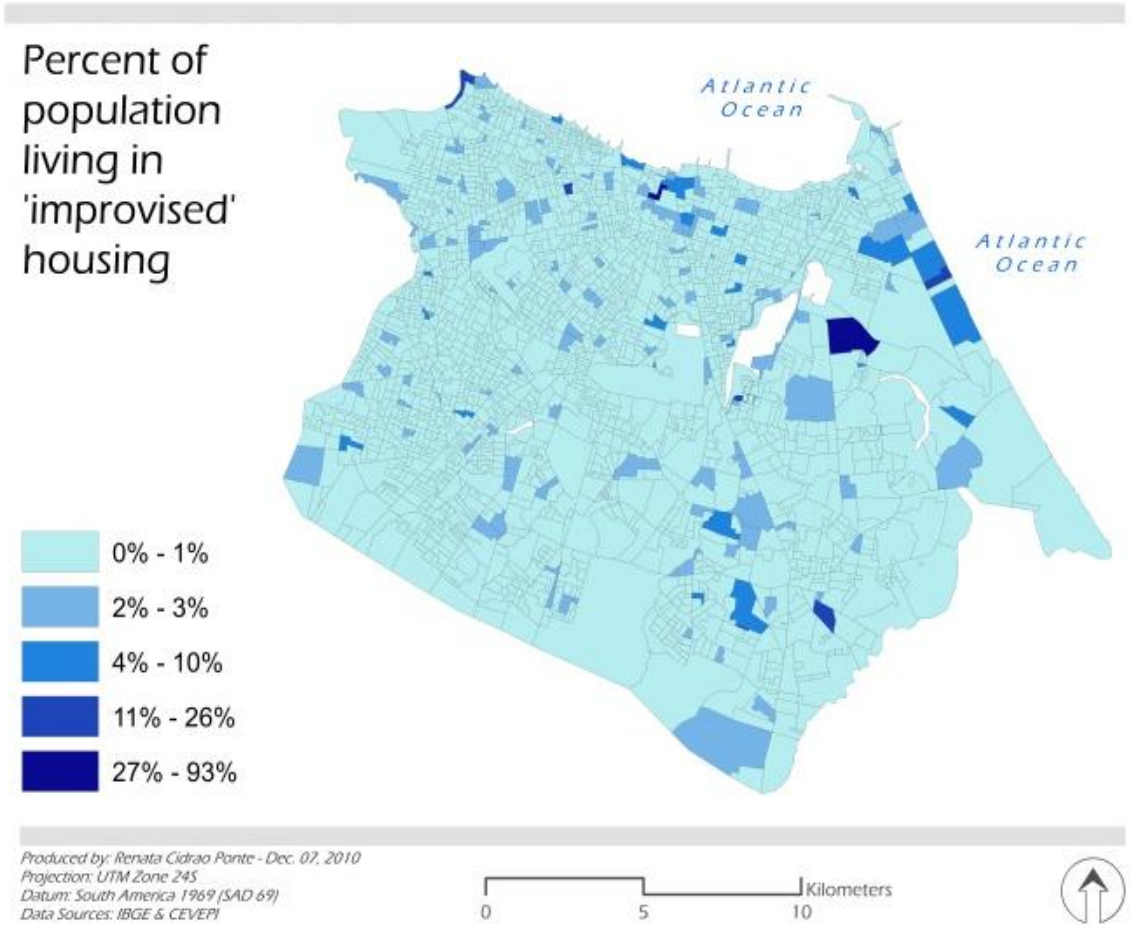

Figure 4.5: Percent of population living in 'improvised' housing (variable 3)

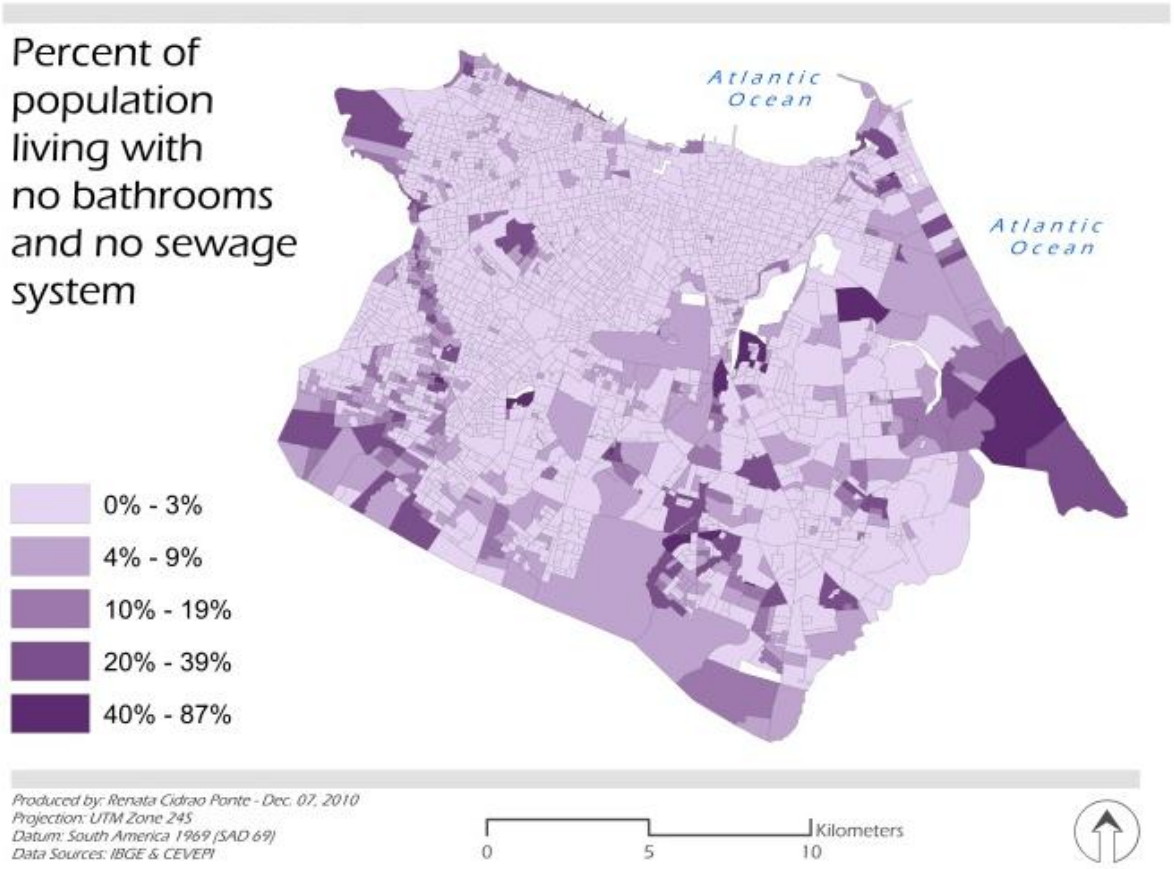

Figure 4.6: Percent of population living with no bathrooms and no sewage system (variable 4)

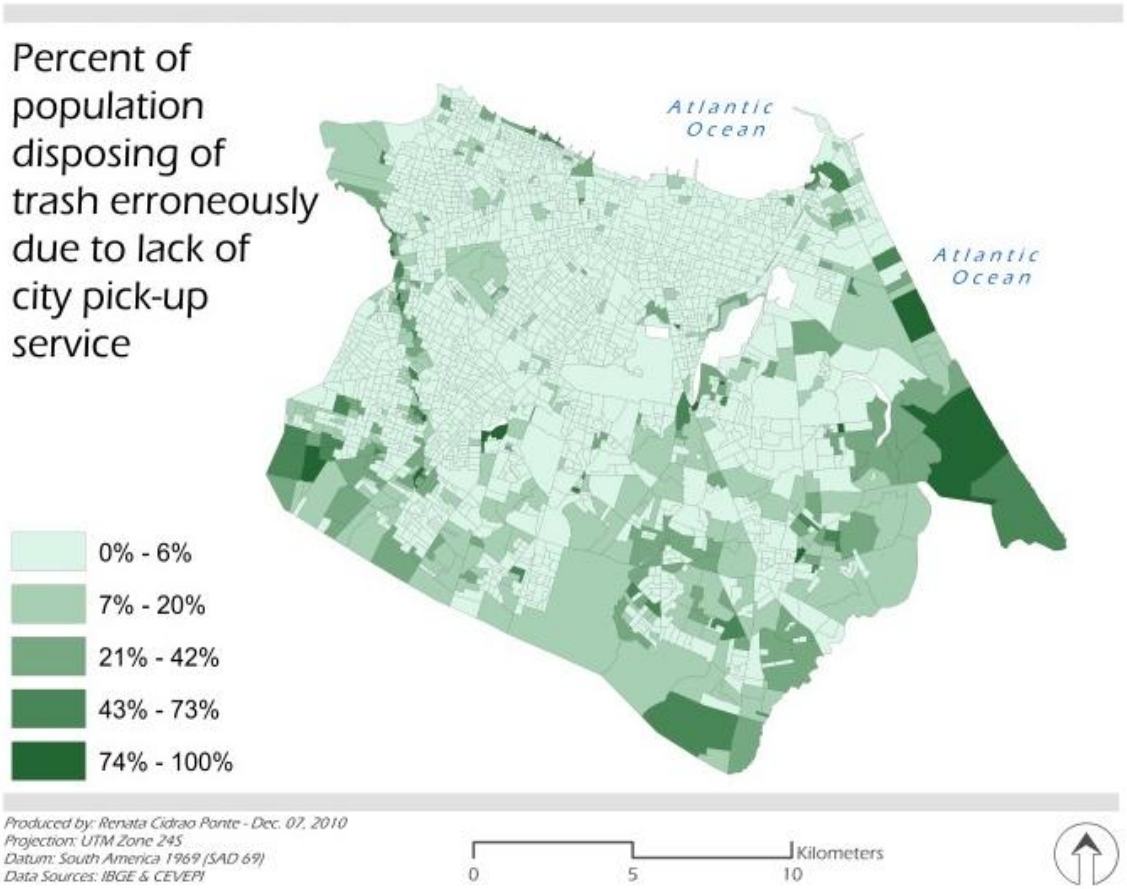

Figure 4.7: Percent of population disposing of trash erroneously (variable 5)

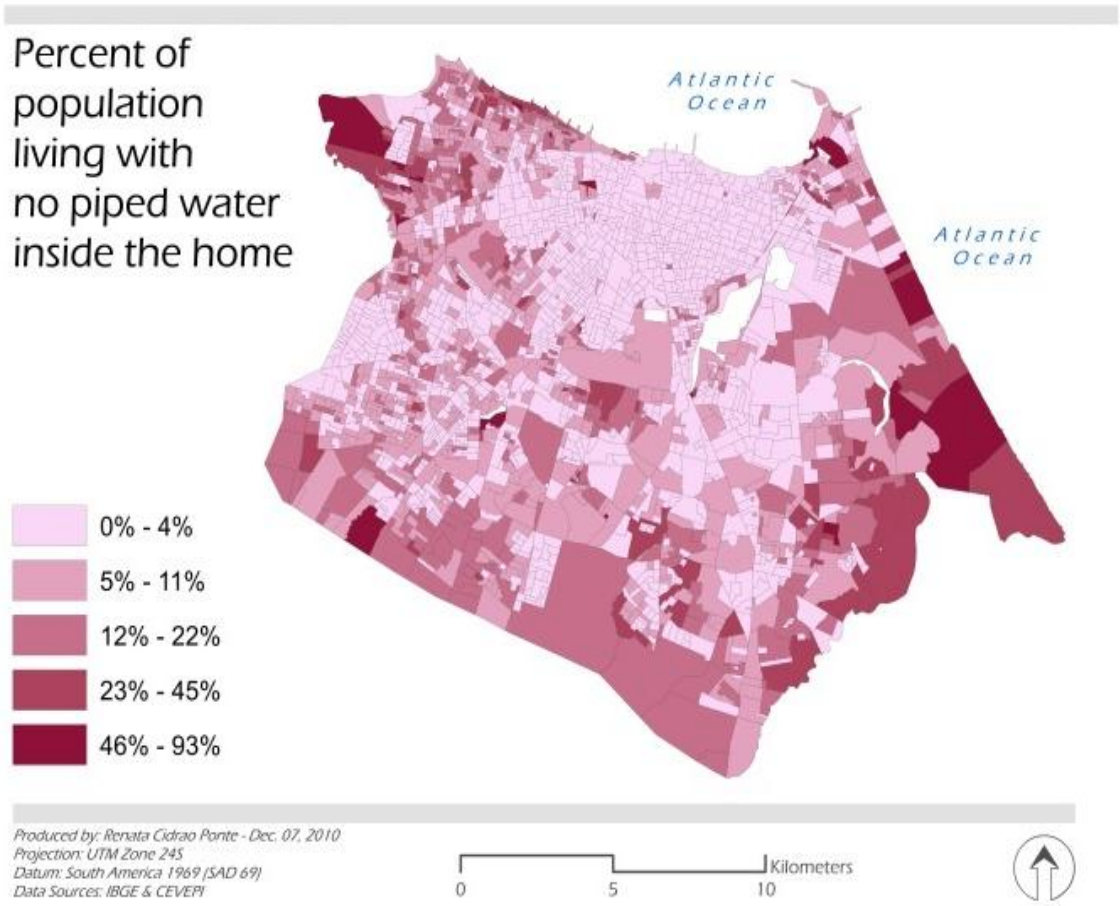

Figure 4.8: Percent of population living with no piped water (variable 6)

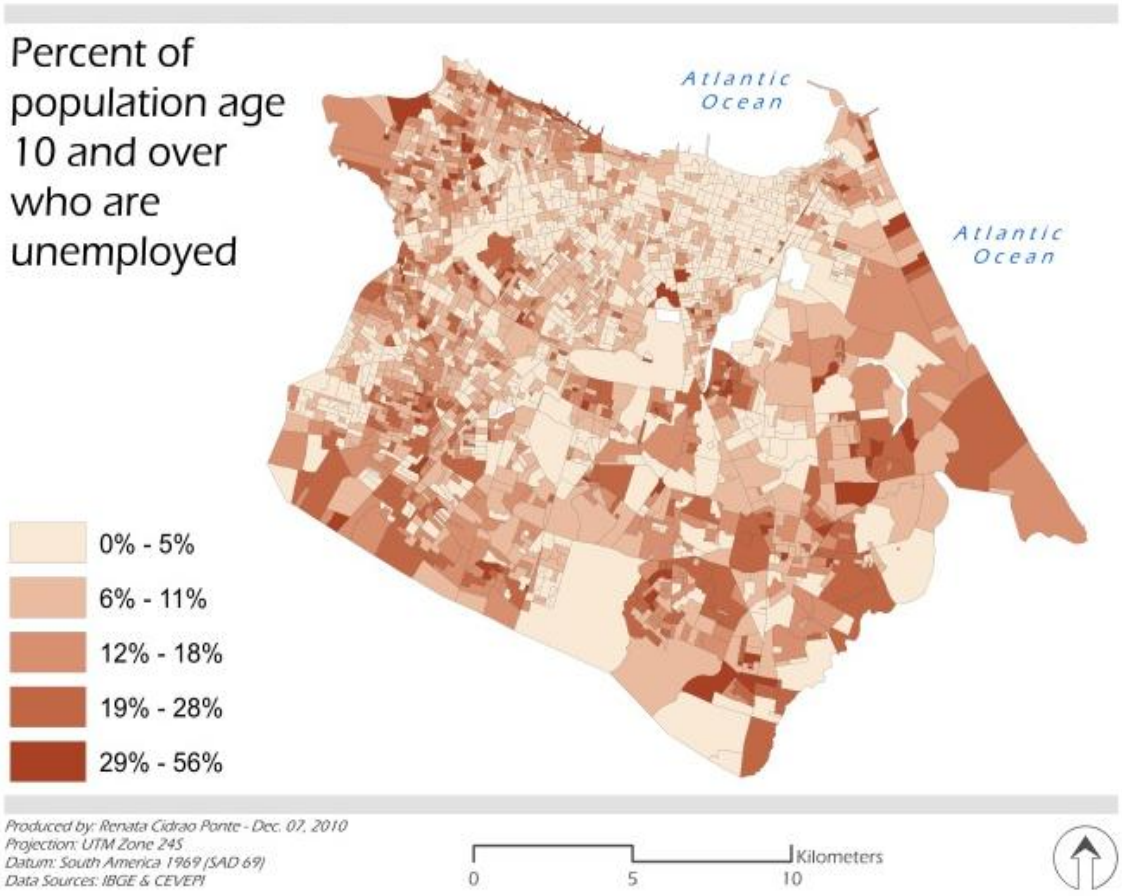

Figure 4.9: Percent of population age 10 and over who are unemployed (variable 7)

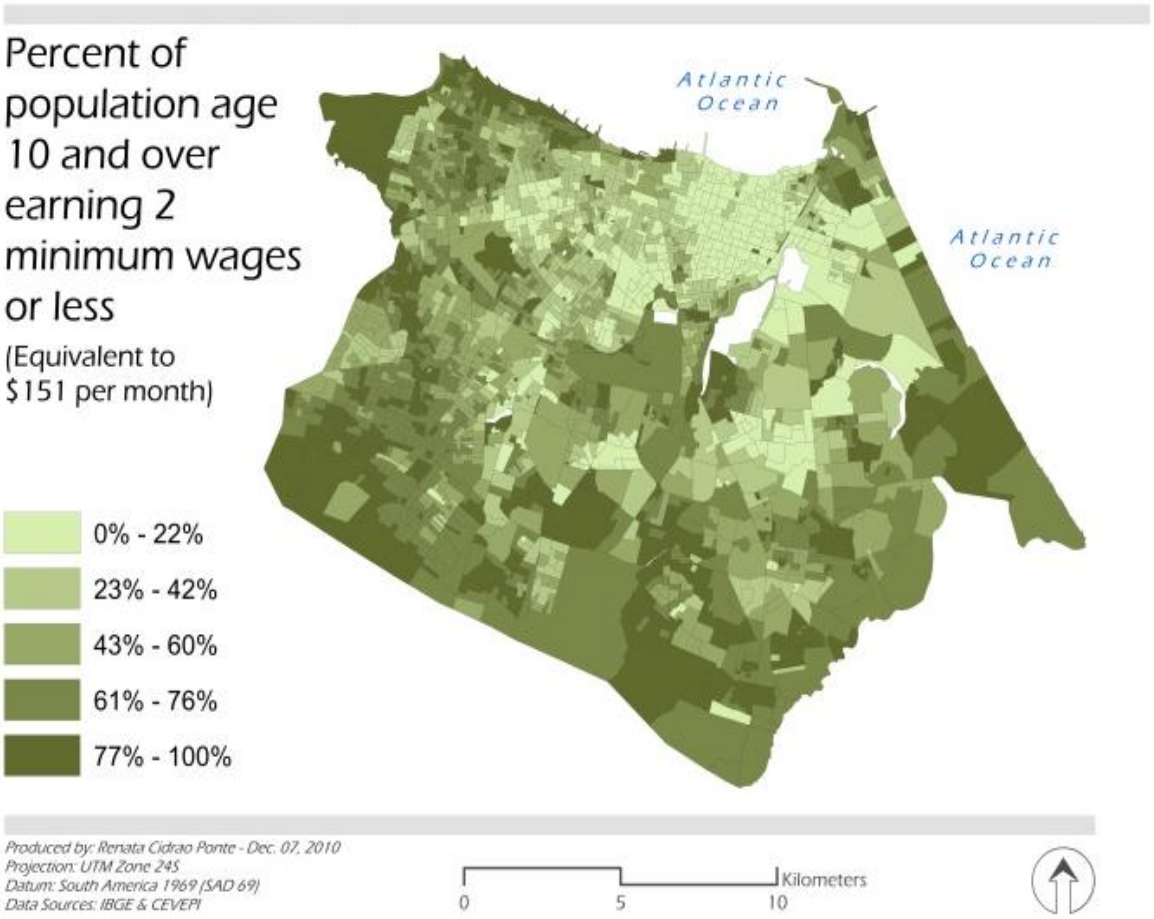

Figure 4.10: Percent of population age 10 and over earning less than $151 per month (variable 8)

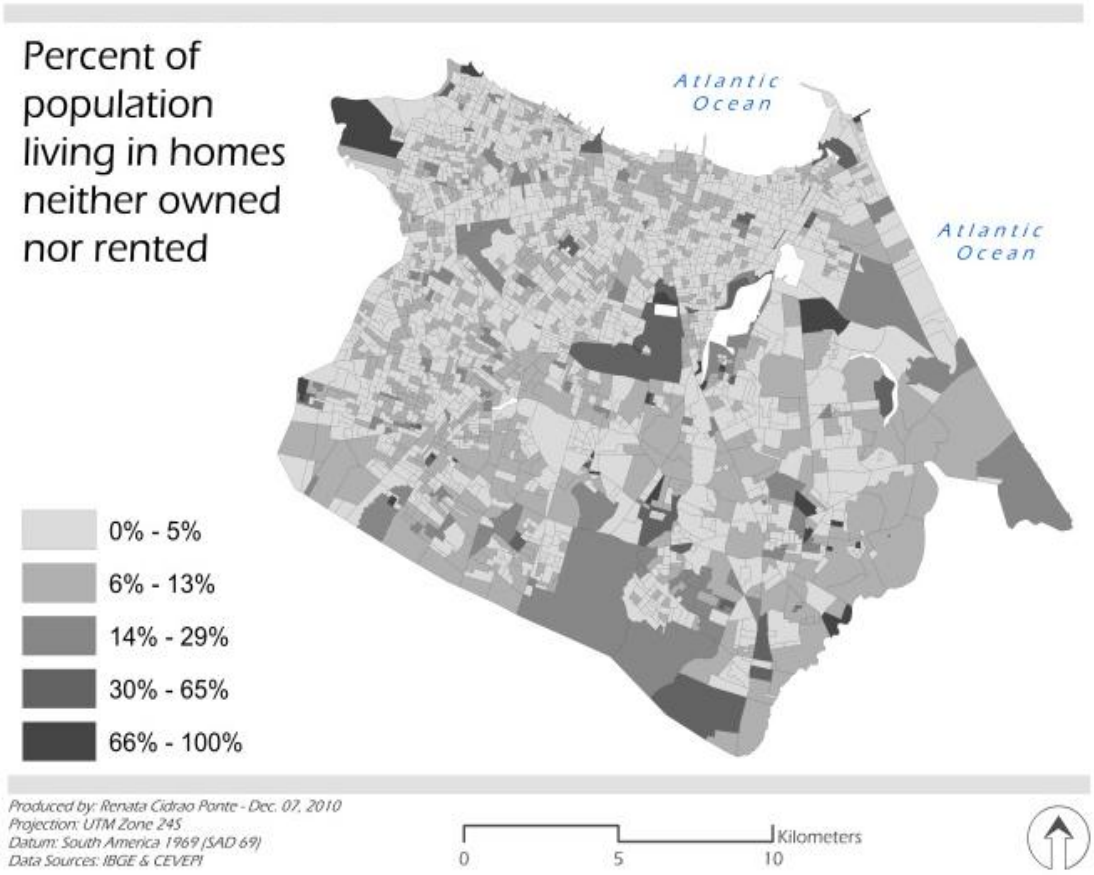

Figure 4.11: Percent of population living in homes neither owned nor rented (variable 9)

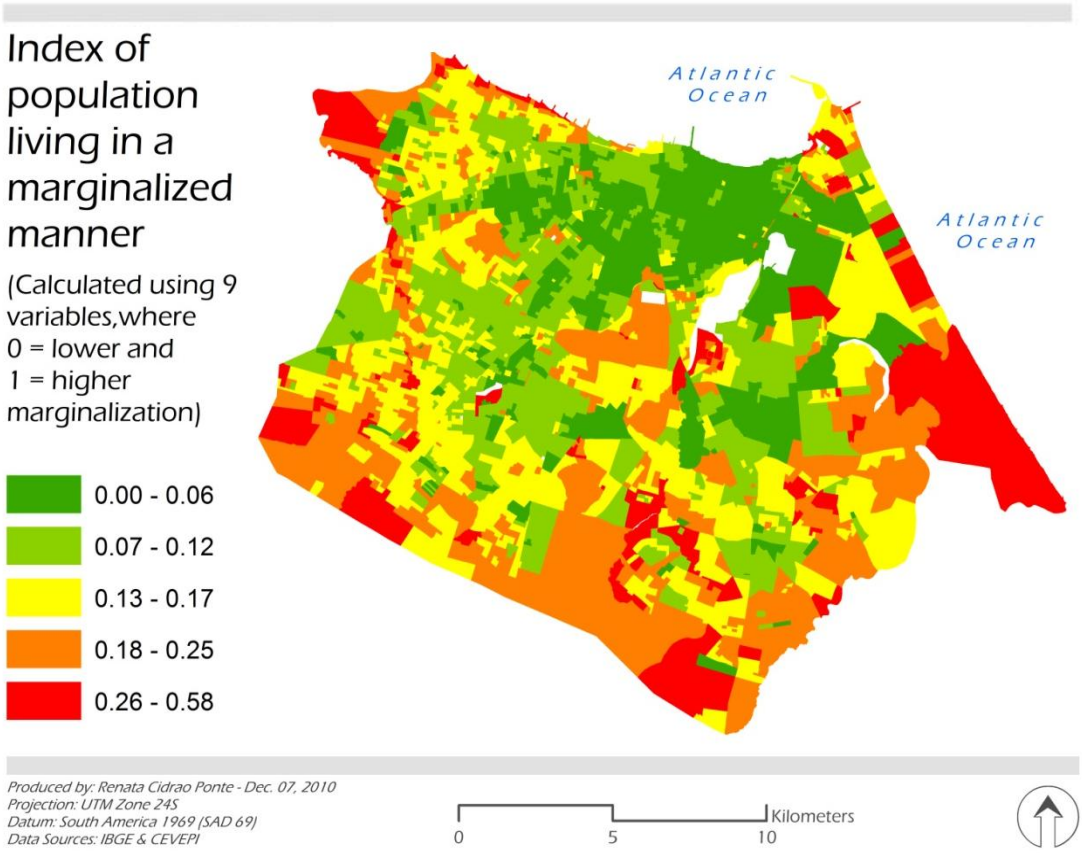

Figure 4.12: Marginalization Index

4.3 SPATIAL PATTERN OF HIV IN FORTALEZA

4.3.1 HIV Incidence in Fortaleza in 2000

The Global Moran's I analyses of HIV incidence per population in Fortaleza for the year 2000 showed a random distribution due to an index value of 0.018, with no statistical significance (p-value of 0.22). Specifically, the relationships were defined by using a first order queen contiguity, to capture the shared variation in HIV incidence through census tracts with common boundaries and corners. The General G analysis for new HIV cases in 2000 demonstrated slight clustering of high values, with a p-value of 0.9 due to a z-score of 1.914375. The Getis-Ord General G showed a clustering of HIV incidence in the year 2000 when the Moran's I showed a random pattern; which required further analysis.

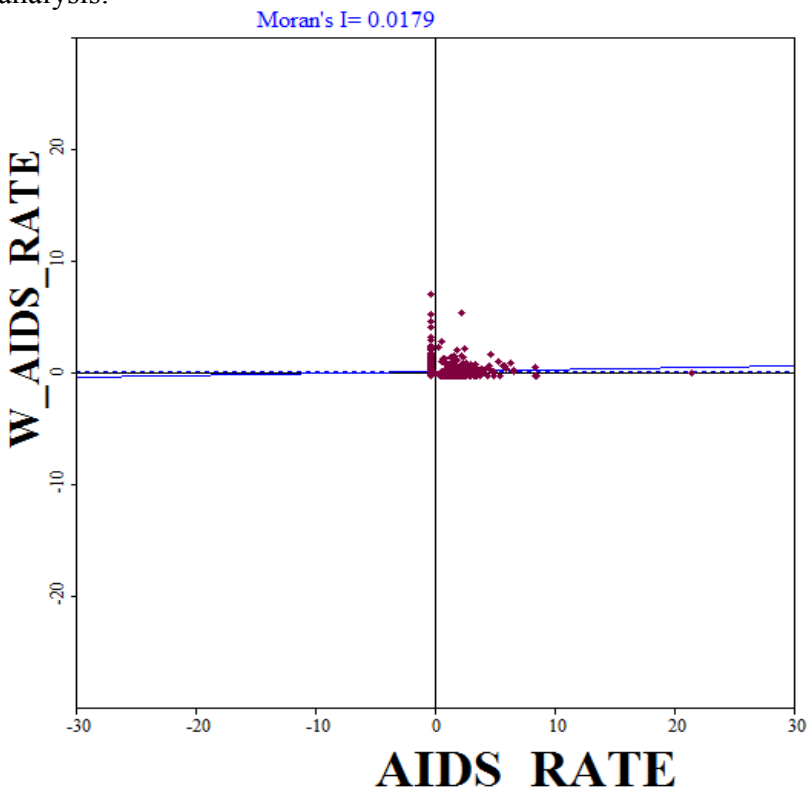

Figure 4.13: Univariate Moran from GeoDa – first order queen contiguity

4.3.2 Marginalization in Fortaleza in 2000

The marginalization index was examined through a similar process as the rates of new cases of HIV in Fortaleza in the year 2000. After running a Moran's I, statistically significant positive autocorrelation was determined with an index value of 0.56 and a p-value of 0.

Table 4.2: Global Spatial Analyses - Z-scores

	Global Moran's I	Getis-Ord General G
HIV Incidence/ Pop	1.217114	1.914375
Marginalization	41.951245	23.391516

4.4 LOCAL SPATIAL AUTOCORRELATION

4.4.1 HIV Incidence in Fortaleza in 2000

LISA for HIV incidence per population identified 43 statistically significant high-high clusters (refer to figure 4.14). There were also 18 outliers of high values surrounded by low values dispersed throughout the city, with the majority of them concentrated on the city's peripheral barrios. Thirteen census tracts displayed low values surrounded by high values, and are all located in the same region - the northeastern section of the city (except one in the heart of downtown).

4.4.2 Marginalization Index for Fortaleza in 2000

As with the HIV rates, the LISA tool was also used on the marginalization index dataset in order to determine where the clusters and outliers where occurring within the study area. The LISA highlights 227 census tracts with low-low clusters in geographic areas known locally as barrios for the upper-middle class, including beach front and suburbs. Only seven census tracts displayed low values surrounded by high values and

similarly eight census tracts were in the opposite situation showing high values surrounded by low values. On the other hand, 190 census tracts displayed high-high clusters of marginalization. Some of these high-high cluster areas are well known *favelas*, riverbed settlements, and peripheral communities (refer to figure 4.15). These can also be seen on the eastern-most tip of the city and could perhaps be due to physical attributes of the land, including large sand dune formations which most traditional types of settlement and development opportunities in that area, allowing for marginal settlement. Or perhaps, this cluster, as with some of the other larger peripheral census tracts, could be a result of the modifiable areal unit problem (MAUP).

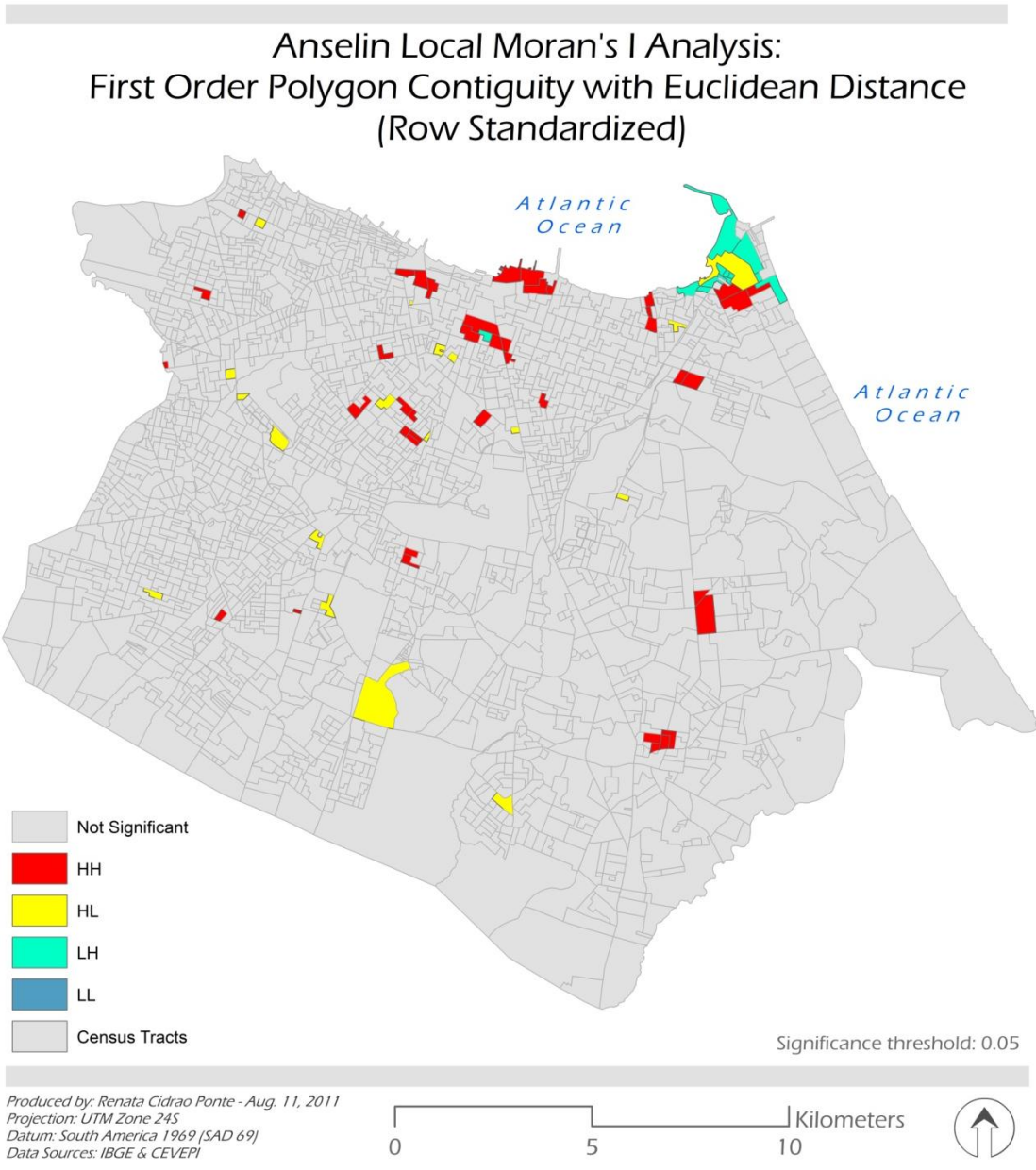

Figure 4.14: LISA - 2000 HIV Incidence

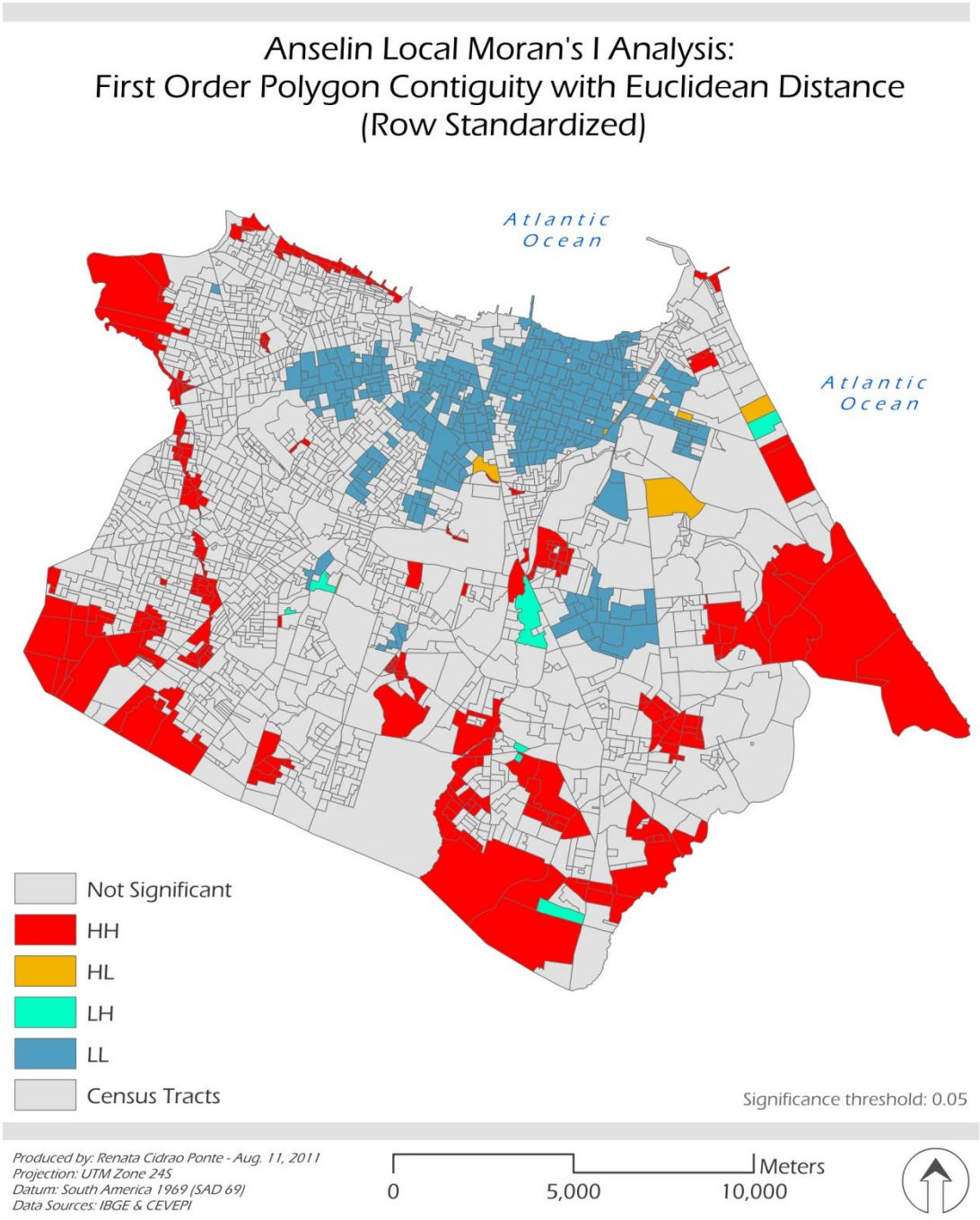

Figure 4.15: LISA Results for the 2000 Marginalization Index

4.5 ORDINARY LEAST SQUARES

The next step in this study was to determine if there was any correlation between marginalization and new cases of HIV in Fortaleza. In order to explore this hypothesis, an Ordinary Least Squares (OLS) was run with the marginalization index as an explanatory variable of the HIV incidence in the year 2000 in the city of Fortaleza. The adjusted r^2 for the OLS was extremely low at 0.005 with a p-value of 0.05, suggesting that the model performance was low and that the marginalization index is explaining less than one percent of the variation in new HIV cases. Interestingly, the value of the coefficient for marginalization index was -0.000538, reflecting a negative relationship between HIV incidence and marginalization. This suggests that the more marginalized a census tract is, the lower the chance of HIV transmission.

The second OLS model incorporated all nine separate values of the marginalization index and displayed an adjusted r^2 of 0.011 suggesting these nine variables only account for 1.1 percent of the variation in the new cases of HIV. It is important to note that some of the VIF values were higher than 7, suggesting an unreliable model. VIF, the Variance Inflation Factor measures redundancy among explanatory variables. Variables with a VIF above 7.5 display similarities with other variables and should be removed. According to this regression, marginalization index variables PPE_15 and PPM, showing VIF values of 14.29 and 10.88 respectfully, could be skewing the model. These two variables are concerned with the population above 15 with only an elementary school education (PPE_15) and with the population earning less than minimum wage of $151.00 per month (PPM).

After analyzing the results of the OLS models, two more OLS models were run as a means to explore the relationship between the marginalization variables and HIV in Fortaleza. Due to the high VIF values of two variables, PPE and PPM, they were

removed from the analysis and another OLS was run in order to determine if these variables were impacting the correlation between HIV and marginalization. The OLS continued to display a low adjusted r^2 of 0.011, and highlighted one additional variable of statistical significance in addition to the percent of population that is illiterate (PPA); percent of population disposing of trash erroneously (PPL). Below is a table with the results.

Table 4.3: Summary of OLS Results - Marginalization index without 2 variables (PPE & PPM)

Variable Name	**Variable Code**	**Coefficient**	**Probability**	**VIF**
Intercept		0.000276	0.000000*	
	PPA	-0.000871	0.000091*	2.037106
	PPH	-0.000065	0.892452	1.009603
	PPO	0.000329	0.171627	1.774856
	PPL	0.000249	0.040349*	1.593856
	PPW	0.000117	0.437721	1.446553
	PPI	-0.000316	0.088814	1.404941
	PPHN	0.000039	0.718168	1.064493

Lastly, an OLS model incorporating only the statistically significant variables (PPA and PPL) continued to demonstrate an adjusted $r^2$of 0.01, suggesting that these two variables explain 1 percent of the HIV incidence per population in Fortaleza. Interestingly, the variables' coefficients are depicting both negative and positive relationships with HIV in Fortaleza. A discussion as to why marginalization accounts for 1.1 percent of HIV incidence in Fortaleza and possible reasons regarding the geographical distributions of the variables used in this study follow the table and figures bellow.

Table 4.4: Summary of OLS Results - statistically significant variable of the marginalization index

Variable Name	Variable Code	Coefficient	Probability	VIF
Intercept		0.000257	0.000000*	
	PPA	-0.000878	0.000001*	2.037106
	PPL	0.000324	0.003026*	1.593856

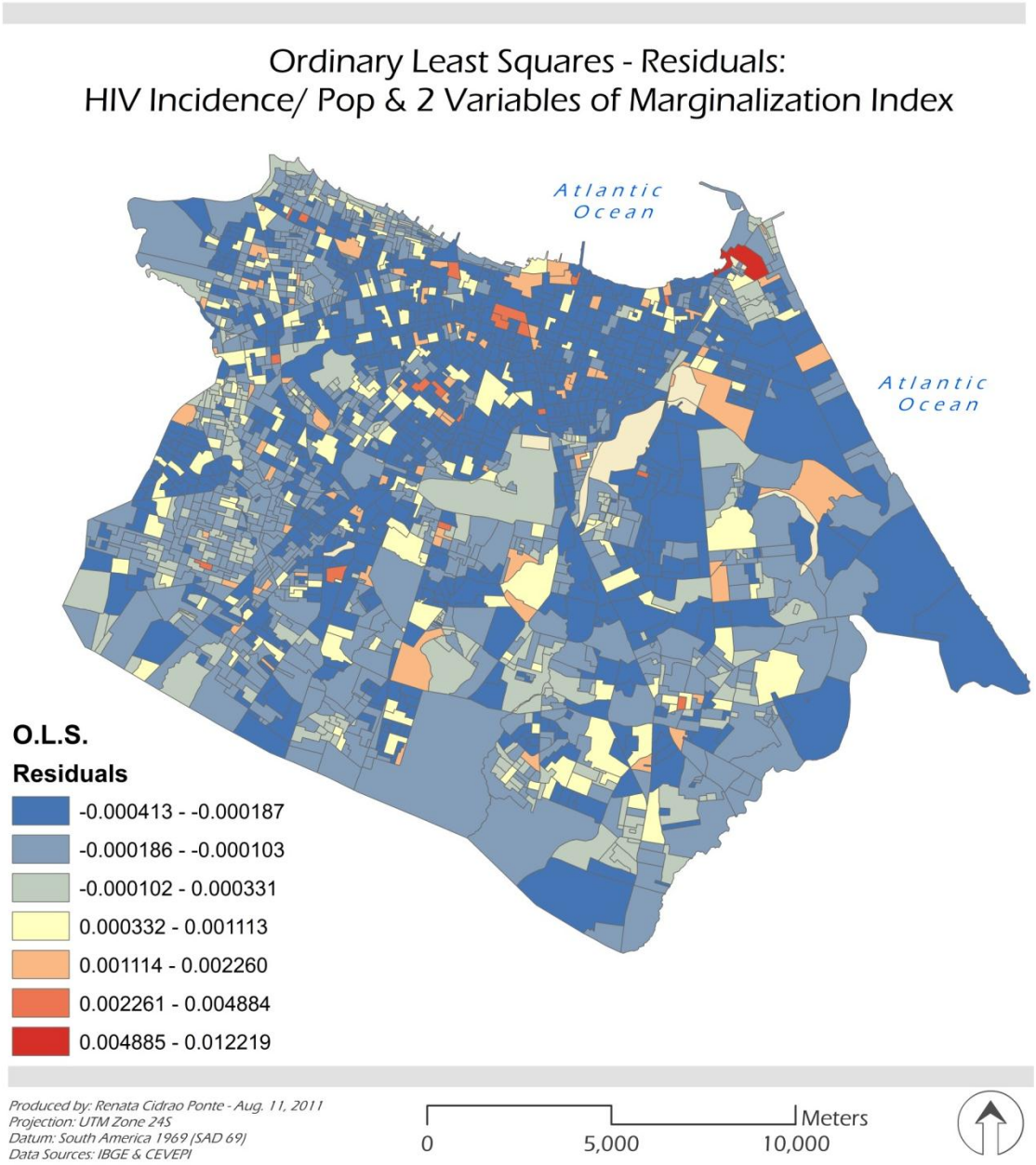

Figure 4.16: OLS Residuals

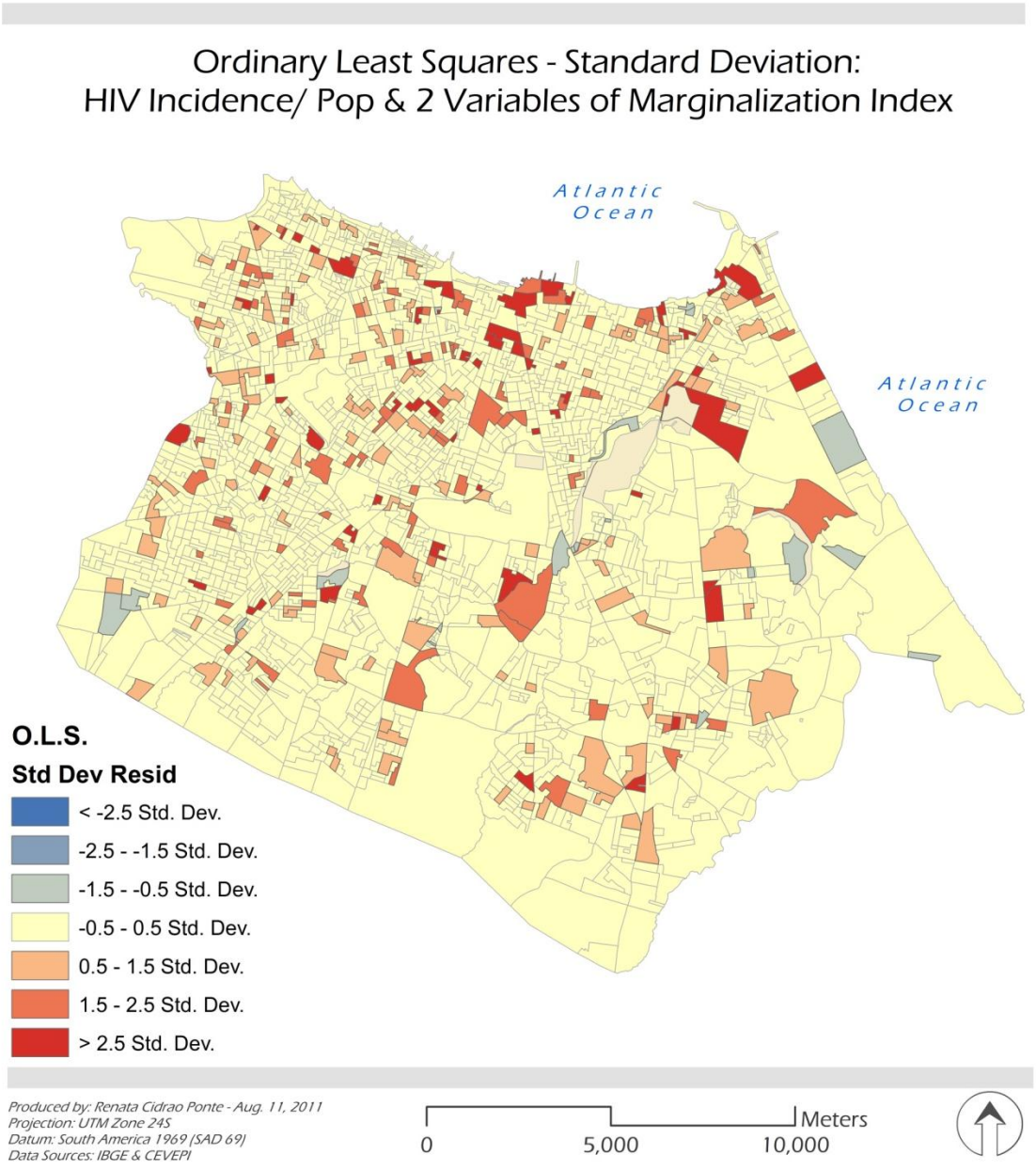

Figure 4.17: Standard Deviation of the OLS Residuals

In order to further explore the relationship between HIV incidence per population and marginalization, a bivariate LISA analyses was utilized (refer to figure 4.19). In applying a bivariate LISA method, spatial clusters were produced that visualized the relationship between these two variables. The clusters which resulted from this analysis do indeed coincide with the clusters from the marginalization index seen in figure 4.15. Specifically, the low-low clusters found in the downtown directly reflect the low-low clusters of marginalization in Fortaleza. Similarly, the high-low clusters seen in the periphery of the city also replicate the high-high clusters in figure 4.15. This is particularly visible in the *favela* in the northwestern-most tip of the city along the northern coast. Although the OLS regression resulted in few statistically significant explanatory variables (refer to table 4.4), the bivariate LISA also demonstrates high-high clusters where both HIV and marginalization are high, supporting the original hypothesis of the study. The plot below shows the Moran's I results for the bivariate LISA; -0.081.

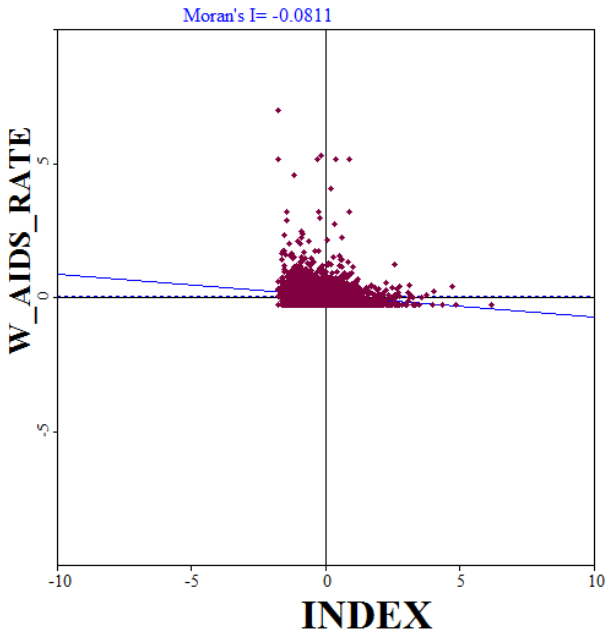

Figure 4.18: Bivariate LISA from GeoDa – first order queen contiguity

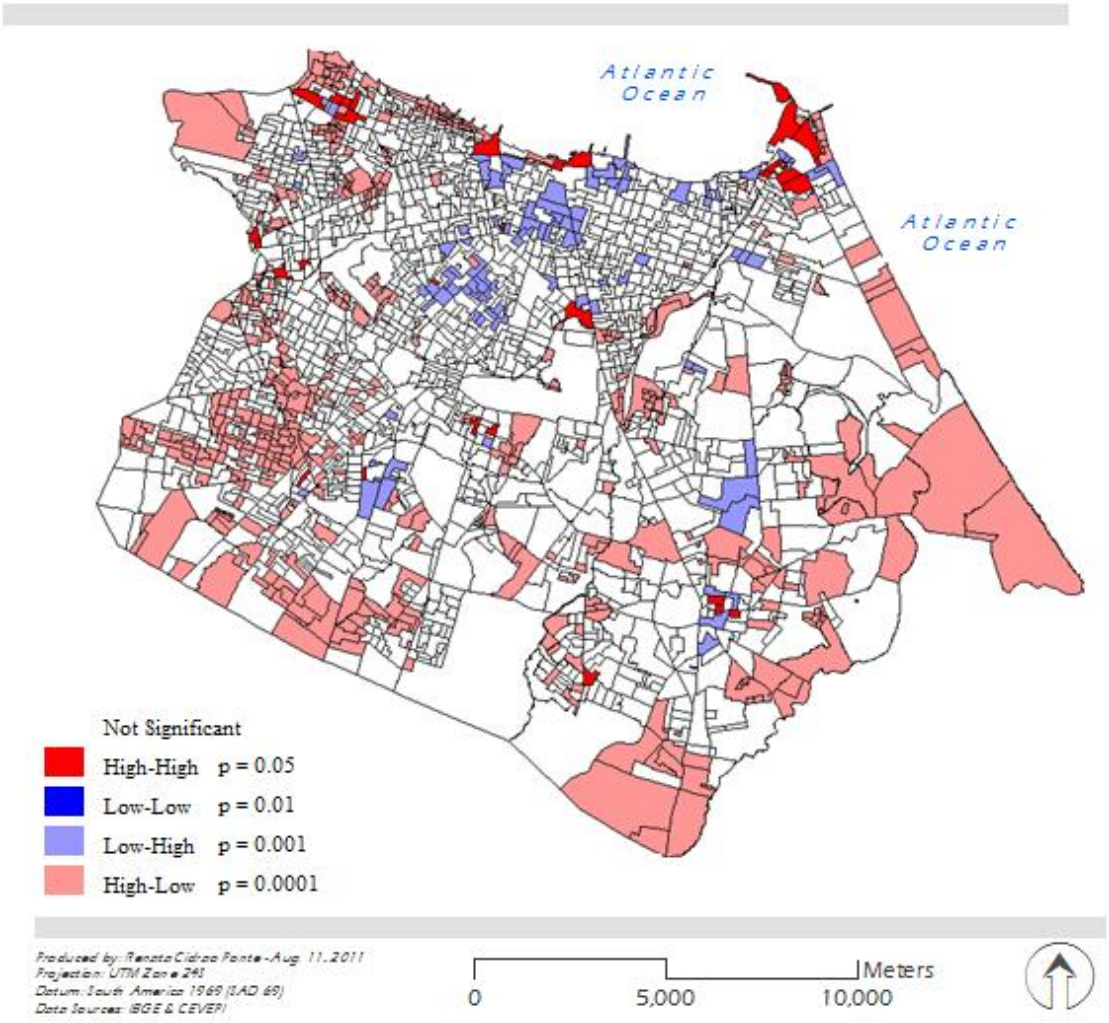

Figure 4.19: Bivariate LISA from GeoDa – HIV incidence per pop. and marginalization

Chapter 5: Discussion & Conclusion

With the aim of examining the status of Fortaleza's HIV/ AIDS situation through a geographical lens, this research sought to highlight HIV clusters and their associations to socio-economic processes as a barrier to health. In particular, the study hypothesized that HIV/AIDS incidence per population is positively correlated with rate of marginalization (where high rates of marginalization correlate to high HIV incidence). In order to analyze these phenomena, spatial analytical techniques were applied as a means to discover trends and clusters that would bring about the needed information related to the central aim of this study: Why is the Brazilian Northeast experiencing rising levels of HIV incidence, when HIV rates have stabilized in other regions of the country?

Studying communicable diseases and the probable causes of its dissemination most certainly will require the inclusion of social factors as an explanatory tool and for heightening researcher insight. Fortaleza remains an interesting case in the Brazilian context of HIV/ AIDS history for it displays economic growth (city with the fifth highest purchasing power per capita in Brazil) yet rising levels of HIV/ AIDS as compared to its Southern counterparts. The hypothesis presented in this study questioned the following:

1. What is the spatial distribution of HIV/ AIDS in Fortaleza? 2. Are there distinguishable clusters of HIV cases and do the cases display spatial autocorrelation? 3. Using a marginalization index, which areas are most marginalized? 4. How is the HIV distribution correlated to one’s socio-economic and socio-demographic status (marginalization)? 5. Which marginalization variables are correlated with HIV cases?

5.1 Conclusions and Discussion

The spatial distribution of HIV incidence in Fortaleza seems not to be concentrated in any particular sector of the city (refer to figure 4.1). Through a visual analysis, a slight tendency of concentration in the western half of the city can be distinguished. This could be attributed to the population density within the municipality, which also depicts patterns of higher density in the western sector of the city. The Global Moran's I analysis indicated a random distribution amongst the new cases of HIV, thus demonstrating that there is no spatial autocorrelation. However, the Getis-Ord General G displayed a 90 percent chance of high valued clusters not being random in the region. Upon further analysis with LISA, small regions in the Northeastern half of the city (downtown) are represented with high-high clusters, whereas the majority of the high-low clusters are on the western region of Fortaleza. No statistically significant clusters of low values surrounded by low values were found. Surprisingly, one census tract in the north section and 12 in the northeastern most section, show an interesting occurrence of outliers of low-high values.

The level of marginalization was taken into consideration as a possible correlate of rising rates of HIV, since Fortaleza experiences high levels of social inequity (with 1 out of 3 people living in a favela). The data suggest that a significant marginalized population does indeed exist in Fortaleza. As discussed in the results, higher levels of marginalization were found to be clustered along the city's peripheral census tracts, with the tourist beach-front areas demonstrating lower levels of marginalization. The results also show that this pattern of marginalization is spatially autocorrelated, with a less than one percent chance of occurring randomly. The LISA for the marginalization index is very reflective of the situation in the city today, with favelas and lower-class districts highlighted as experiencing higher levels of marginalization. As anticipated by this study,

the urban core and downtown show less marginalization in accordance to the affluent neighborhoods, more infrastructures due to the historical development of the city and also reflecting the cultural appreciation of living close to the beach.

Almost all high-high clusters of HIV incidence fall outside the areas of low-low clusters of marginalization, except for a few census tracts in the Cocó barrio. The Cocó barrio, which encompasses the Cocó Ecological Park in east-central Fortaleza, displayed interesting patterns because it depicted low-low clusters of marginalization, but high-high clusters of HIV incidence. The Cocó barrio is an area of growth and transition in the city of Fortaleza. It also houses a favela in the middle of the barrio. This favela is known for its high levels of criminal activity, prostitution and dense living arrangements. Due to the relatively small size of this favela (10 city blocks), perhaps the social marginalization of the corresponding census tracts did not appear statistically significant in the analyses provided in this study.

Table 4.1 shows the socio-demographic variables taken into consideration for this research. Comparing the data between males and females in Fortaleza, the census shows that although a smaller percentage of females as compared to males are illiterate, it is important to consider that the state of Ceará inhabits 212 million more women than men (Newspaper: Diário do Nordeste 04/30/2011). This demographic disparity serves as a window to the relative deprivation experienced by women in Fortaleza, as the table also shows that households lead by women are more likely to have no income (unemployed) or to be earning less than $150 a month as compared male-led households. These structural and compositional variables are argued to have an impact on disease transmission within sexual networks (Scribner et al 2010).

In reference to the research question regarding the correlation between marginalization variables and HIV cases, an OLS was performed. According to this

analysis, the marginalization variables account for 1.1% of the variance of the HIV cases in Fortaleza. The only variable that displayed statistical significance was referring to the population 15 years of age that are illiterate (PPA_15). This statistically significant variable likely represents the poorer sectors of the population who perceive less control over their health, environment and the outcome of their actions. Perhaps this is also a sub-population that experiences heightened mobility in their search for employment, as they are likely to be involved transitional jobs (street cleaner, domestic worker, etc). Higher levels of mobility have indeed been correlated with higher incidence of HIV/ AIDS (Yang 2005). Previous researches which have analyzed health standards as a factor of infrastructural, financial, or social development predisposing communities to STIs, incorporated permanent shelter versus homelessness as one of the indicators of a risk environment for HIV transmission. As the socio-ecological model and the risk-environment framework explain, the interactions amongst an individual's behaviors, personal characteristics, environment and health related behaviors occur within a societal and political umbrella where racism, stigma, institutions and policies define risk environments and behaviors like a trickle-down effect. Even if the individual is aware of safe sex practice behaviors and has the intention of partaking in such behavior, there are external motivational factors impeding upon these actions which have been recognized by the theory of planned behavior, such as time, money, and skills.

According to the theory of reasoned action, one's own evaluation of positive or negative opinion of a particular behavior is directly correlated to whether they will partake in that action. Brazil is known for its "machismo" culture, which is especially strong in the Northeast. This can cause deterrence in the use of condoms and hinder women's ability to negotiate safe sex practices in heterosexual relationships. If the public's understanding of behaviors associated with HIV transmission routes are

improved, than the opinion of a particular action could but may not directly translate to safe sex practices due to gender differences, inequity, and cultural customs, as explained by the socio-ecological model. As a means to minimize barriers, Fortaleza's health ministry has increased efforts to make safe sex practices accessible to all socio-economic levels of the population by distributing condoms at no cost, and expanding locations of mobile clinics, thus including favelas and lower-income neighborhoods.

Nonetheless, 99% of cases are explained by factors outside of marginalization. Resonating with these results are the words of Fishbein (1991, xxi) stating that, "it is not who one is, but what one does, that determines whether one will or will not be exposed to HIV", demonstrating that poverty is complex and does not define one's actions. Influences of political climate and the importance given by political powers to manage and educate the public about the HIV epidemic generates conditions which constrain or promote individual choices concerning sexual practices. The results of this study reflect that behavioral based interventions are working in Fortaleza due to the fact that these interventions are coupled with an environment that is growing financially, educationally and culturally.

As the health belief model states, the notion of perceived threat is vital to the probability that an individual will partake in preventative health actions. The Ministry of Health has invested in campaigns to demonstrate to the general population that HIV does not discriminate and instill the reality that all individuals are at risk. These MoH sponsored campaigns also appeal to the individual's Cues to Actions by demonstrating the accessibility of health care and benefits, and thus attempting to influence the perceptions of not only the individual, but also their family and friends. Campaigns also advocate the disclosure of HIV+ status by PLHIV in order to minimize the images of AIDS as a debilitating and horrific disease and serve to spark a quotidian habit in

education and communication, such as the slogan for a 2002 health campaign: "Using a condom with your boyfriend can also be a father-son talk" (PAHO 2008). The STD/ AIDS Programme in Brazil must also continue mass media programs to educate, and de-stigmatize HIV/ AIDS, perhaps through early sex education in schools and by working with local programs.

Brazil's mandate of universal access to antiretroviral therapy was well over two decades ago and most of the country has managed to stabilize the dissemination of HIV, except the Northeast, which is experiencing trends of increased HIV infections. Understanding the situation in Fortaleza serves as a means to better (geographically) serve the seropositive population and provide methods to ever improve Brazil's model towards HIV/AIDS management.

5.2 RESEARCH LIMITATIONS

The research of analyzing the spread of HIV/AIDS has improved as nations gain access to information technology and as global awareness and urgency increases towards this pandemic. Yet, many difficulties still arise concerning the availability and legitimacy of HIV/AIDS data, questions of patient privacy and the complexity tied to the surveillance of sexually transmitted infections. Many cultural aspects that accompany research of HIV/ AIDS were not taken into consideration during the analyses of this study. Such complex phenomena could not be included in the scope of this study, but perhaps could be explored further and more comprehensively through a qualitative research.

In order to fully incorporate the Risk Environment framework, factors at the macro-, meso-, and micro-level should be analyzed. This research only covered the micro- (and perhaps touched upon meso-) level factors, fully aware that different patterns and factors are likely to arise from further investigating the macro-level factors. Cultural beliefs and political climate were the used in interpreting trends in an attempt to incorporate macro-level variables.

As discussed in the results, possible problems with variable multicollinearity arose with the first OLS performed - some of the nine variables used in the marginalization index can hold strong correlations among each other. The two variables which demonstrated that were the most problematic were representing the population above the age of 15 with only a primary school education, which could be conflicting with the variable of illiteracy, and the percent of population earning less than minimum wage. Such correlations could impact the regression model by introducing redundancy. Further spatial analyses with individual the statistically significant variables were preformed to minimize such collinearity.

Acquiring arterial data is also recommended for this research. Inputting major roads would allow for some insight into the movement patterns of the people of Fortaleza and also provide a guide for analyzing health care accessibility, particularly HIV/ AIDS medical care.

5.3 Future Research

Further researching concerning health care accessibility in Fortaleza could prove beneficial in analyzing HIV trends and possible solutions for rising HIV incidence. Considering the context of Fortaleza, where only one hospital is fully equipped for 24-

hour (including overnight stay) for HIV/ AIDS cases, researching this further could potentially expose areas not covered by hospital care. Acquiring additional information regarding which medical centers provides services for the seropositive community, and specifically the type of service provided could be further analyzed to discover whether growing incidence is correlated with distance to hospitals equipped to provide care for those living with HIV/ AIDS. Acquiring arterial data would also be beneficial for future research. Inputting major roads would allow for some insight into the movement patterns of the people of Fortaleza and also provide a guide for analyzing health care accessibility, particularly HIV/ AIDS medical care. With this in mind, future research questions linger, such as, could the decentralization of the HIV/ AIDS health services positively impact the management of the pandemic and better service this 'vulnerable'/ 'at-risk' population? Could such an action alleviate budgetary worries concerning the continuous production of HIV/ AIDS medication?

Studying health disparities and disease dissemination through a geospatial lens will allow researchers to gain knowledge about on-the-ground trends. HIV/AIDS is a growing global pandemic, and the Brazilian government has been deemed successful at managing the disease. Analyzing areas within Brazil that are not part of this success story could possibly give insight to other regions that have also failed at managing HIV/ AIDS. Spatial analyses coupled with social trends, if further studied, could reveal new paths for health policies and prevention strategies for communicable diseases.

Future HIV/ AIDS research and interventions need to consider dynamic multilevel interaction of contextual frameworks, and as advocated by Rhodes and Simic (2005), encompassing of poverty alleviation, economic reform, policy change, human rights, and community action. In conjunction with the risk-environment framework, these

macro-level changes in Brazil will continue to impact micro-level risk-environments in a positive manner. This broader and long term vision encompasses why Brazil has experienced positive results with its HIV model approach, all the while, explaining why the poorer and less developed Northeast still sees rising HIV incidence today.

Glossary

AIDS – Acquired Immunodeficiency Syndrome

ANVISA – Brazilian National Sanitary Supervision Agency

ARV – Antiretroviral drugs

ARTs – Antiretroviral therapies/ treatments

AZT – Zidovudine Therapy (first AIDS medicine on the market, FDA approved)

CSR – Complete Spatial Randomness

FDA – (United States) Food and Drug Administration

GDP – Gross Domestic Product

GIS – Geographic Information Systems

GPS – Global Positioning Systems

GTPI – Group on Intellectual Property

HAART – Highly Active Antiretroviral Therapy

HBM – Health Belief Model

HDI – Human Development Index

HIV – Human Immunodeficiency Virus

ICRW – International Center for Research on Women

IGOs – Inter-Governmental Organizations

LISA – Local Indicators of Spatial Autocorrelation

MI – Marginalization Index

MoH – Ministry of Health

PLHIV – People living with HIV

Rebrip – Brazilian Network for the Integration of Peoples

RS – Remote Sensing

SES – Socio-Economic Status

STI – Sexually Transmitted Infection

SUS – Sistema Único de Saúde (Unified Health System)

TpB – Theory of Planned Behavior

TRA – Theory of Reasoned Action

TRIPS – Trade-Related Aspects of Intellectual Property Rights (World Trade Organization)

UN – United Nations

UNESCO – United Nations Educational, Scientific and Cultural Organization

References

Abdool Karim, S.S., Naidoo, K., Grobler, A., Padayatchi, N., Baxter, C., Gray, A., Gengiah, T., et al. 2010. Timing of Initiation of Antiretroviral Drugs during Tuberculosis Therapy. *N Engl Journal of Medicine*, 362(8): 697-706. doi:10.1056/NEJMoa0905848

ABIA – Brazilian Interdisciplinary AIDS Association (Organized by Parker, R. and Terto Jr., V.) Soledariedade: A ABIA na Virada do Milenio, ABIA, Rio de Janeiro, 2001.

Adams, Paul C. 2009. Geographies of Media and Communication.West Sussex, United Kingdom: Wiley-Blackwell, John Wiley & Sons Publishing.

Airhihenbuwa, C et al. 2000. A Critical Assessment of Theories/Models used in Health Communication for HIV/AIDS. *Journal of Health Communication*, 5 (suppl.1): 5-15.

Ajzen, Icek. 1991. The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50:179-211.

Ajzen, Icek & Fishbein, Martin. 1975. Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Reading, MA: Addison-Wesley.

Ajzen, Icek & Fishbein, Martin. 1980. Understanding attitudes and predicting social behavior. Englewood Cliffs, NJ: Prentice-Hall.

Albarracín, Dolores, Johnson, Blair T., Fishbein, Martin, and Muellerleile, Paige, A. 2001. Theories of Reasoned Action and Planned Behavior as Models of Condom Use: A Meta-Analysis. *CHIP Documents.* Paper 8. http://digitalcommons.uconn.edu/chip_docs/8 (Psychological Bulletin, 2001, Vol. 127 (1): 142-161).

Anselin, Luc. 1995. Local Indicators of Spatial Association-LISA. *Geographical Analysis*, 27(2): 93-115.

Araújo, A.M.M. & Carleial, A.N. 2003. Opulência e Miséria nos Bairros de Fortaleza (Ceará/ Brasil). *Revista Electrónica de Geografía y Ciencias Sociales*, Vol. VII 146(30): 1-15.

Arden, William B. 12/ 2008. "Medical Geography in Public Health and Tropical Medicine: Case Studies from Brazil" (Ph.D. diss., Louisiana State University and Agricultural and Mechanical College).

AVERT – Averting HIV and AIDS: International AIDS Charity. www.avert.org Last Updated: May 12, 2010. *Accessed May 16, 2010.*

Ayles, H., Sismanidis, C., Beyers, N., Hayes, R., & Godfrey-Faussett, P. 2008. ZAMSTAR, The Zambia South Africa TB and HIV Reduction study: Design of a

2 x 2 factorial community randomized trial. *Trials*, **9**(1), 63. doi:10.1186/1745-6215-9-63

Ban Ki-moon op-ed, 2008 (6th August), 'The stigma factor', The Washington Times

Barnett, T. & Whiteside, A. 2006. AIDS in the Twenty-First Century - Disease and Globalization. Second Edition. Palgrave MacMillan, New York, NY.

Barrett, Frank A. & Atkinson College, Dept. of Geography. 2000. *Disease & Geography: the history of an idea*, Toronto, Canada: Atkinson College, Department of Geography.

Becker, M. H. 1994. The Health Belief Model and personal health behavior. Health Education Monographs.

Bento, V.R.d.S. & Carleial, A.N. 2010. Indicadores Sócio-Demográficos na Definição de Centralidade em Fortaleza. Paper presented at the XVII Encontro Nacional de Estudos Populacionais, realizado em Caxambu, MG, Brasil, de 20 a 24 de setembro de 2010.

Black, M., Ebener, S., Aguilar, P.N., Vidaurre, M., Morjani, Z. Using GIS to Measure Physical Accessibility to Health Care. 2004. Paper presented during the 2004 International Health Users conference, Washington D.C. *World Health Organization, Pan American Health Organization, and RMIT University.*

Bowerman, R.J. 2004. Tuberculin skin testing in BCG-vaccinated populations of adults and children at high risk for tuberculosis in Taiwan. *The International Journal of Tuberculosis and Lung Disease*, 8, 1228-1233.

Cano, J., Descalzo, M., Ndong-Mabale, N., Ndong-Asumu, P., Bobuakasi, L., Buatiché, J., Nzambo-Ondo, S., Ondo-Esono, M., Benito, A., & Roche, J. 2007. Spatial and temporal variability of the Glossina palpalis palpalis population in the Mbini focus. *International Journal of Health Geographics*, 6: 36.

CDC – Center for Disease Control, 2009. Managing Drug Interactions in the Treatment of HIV-Related Tuberculosis.

Chaves, G.C., Vieira, M.F., & Reis, R. 2008. Access to Medicines and Intellectual Property in Brazil: Reflections and Strategies of Civil Society. SUR – International Journal on Human Rights. São Paulo. Year 5, Number 8:163 – 189. Available at: http://www.surjournal.org/eng/conteudos/getArtigo8.php?artigo=8,artigo_chaves.htm. Accessed: December 15, 2010.

Chaves, G.C. 2006. *Patentes farmacêuticas: por que dificultam o acesso a medicamentos? (Pharmaceutical patents: Why do they impose difficulties in accessing medications?),* Rio de Janeiro, ABIA. Available at: <http://www.abiaids.org.br/cedoc/publicacoes>, last access on December 15, 2010.

Chaves, L.F., Cohen, J.M., Pascual, M., & Wilson, M.L. 2008. Social Exclusion Modifies Climate and Deforestation Impacts on a Vector-Borne Disease. *PLoS Neglected Tropical Diseases*, 2(2): 176-183.

CONAPO – Consejo Nacional de Población (National Population Agency). Índices de marginación: Anexo C - Metodología de estimación del índice de marginación (Marginalization Index: Appendix C – Methodology for estimating the marginalizatin index), 2005. México D. F., C. P.

Costa, C., Santana, P., Almendra, R., Freitas, P., Zaky, A. 2009. And When There is No Information? The Case of São Tomé and Principe. Marquês de Valle Flôr Institute. II International Conference on Sustainability Measurement and Modelling, CIMNE, Barcelona.

Croner, C.M, Gesler, W.M., and Albert D.P. 2000. Glossary. In *Spatial Analysis, GIS, and Remote Sensing Applications in the Health Sciences.* eds. Albert, Donald P., Gesler, Wilbert M., and Levergood, Barbara. Chelsea, MI: Sleeping Bear Press.

Deacon, H. *et al*. 2005. Understanding HIV/AIDS stigma: A theoretical and methodological analysis. Cape Town, South Africa: Research Programmes on Social Cohesion and Identity & The Social Aspects of HIV/AIDS and Health.

De Lisser, R, Observational Experience: HIV/AIDS Care in Fortaleza, Brazil, Center for Global Health Scholarly Report, 2001.

Dean, H.D., Fleming, P.L., Marconi, K. 2005. Uses of HIV and other public data for HIV prevention and care planning. *AIDS Education Prevention*, 17(suppl B):1–2

Diário do Nordeste (CE), 09/12/2006. A cada dia, dois novos casos de Aids em Fortaleza.

Diário do Nordeste (CE), 04/30/2011. Ceará tem 212 mil mulheres a mais do que homens.

DiClemente, Ralph J. and Peterson, John, L. 1994. Changing HIV/AIDS Risk Behaviors, The Role of Behavioral Interventions. In *Preventing AIDS: Theories and Methods of Behavioral Interventions*, eds. DiClemente, Ralph J., Peterson, John L. 01-04. New York, New York: Plenum Press.

Dourado, I., Veras, MA., de SM *et al*. 2006. Tendencias da epidemia de Aids no Brasil apos a terapia anti-retroviral, *Rev Saúde Pública*, 40 (suppl.):9-17.

Drewnowski, Rehm, & Solet 2007. Disparities in obesity rates: Analysis by ZIP code area, *Social Science & Medicine*, December: 65(12): 2458-2463.

Eba, P.M. Stigma[ta]: Re-Exploring HIV-Related Stigma. AIDS Review 2007. Centre for the Studies of AIDS, University of Pretoria 2008.

Elliot, P. Cuzick, J., and English, D. 1996. *Geographical and Environmental Epidemiology: Methods for Small-area Studies*. Oxford, U.K.: Oxford Medical Publications.

Farmer, P. & Castro, A. 2005. Understanding and addressing AIDS-Related stigma: From anthropological theory to clinical practice in Haiti. *American Journal of Public Health* 95(1): 53-59.

Ferreira, F.H.G., Lanjouw, P., Neri, M. 2003. A robust poverty profile for Brazil using multiple data sources*. *Revista Brasileira de Economia*, 57(1):59-92.

Fishbein, Martin. 1991. Introduction. In *The Theory of Reasoned Action - Its Application to AIDS-Preventive Behaviour*, eds. Terry, Deborah J, Gallois, Cynthia, and McCamish, Malcolm. xv-xxv. Oxford, England: Pergamon Press.

Ford N., Wilson D., Chaves G.C., Lotrowska M., & Kijtiwatchakul K. 2007. Sustaining access to antiretroviral therapy in the less-developed world: lessons from Brazil and Thailand. AIDS 21(suppl. 4):S21 – S29.

Fotheringham, A.S., Bunsdon, C. & Charlton, M. 2002. *Geographically Weighted Regression: the Analysis of Spatially Varying Relationships*, John Wiley & Sons, Inc.

Galvao J. 2002. Access to antiretroviral drugs in Brazil. Lancet. 360 (9348):1862 – 1865.

Getis, A. & Ord, J.K. 1992. The analysis of spatial association by the use of distance statistics. *Geographical Analysis*, 24: 189-206.

Glass, Thomas A. 2000. Update: spatial aspects of epidemiology: the interface with medical geography. *Epidemiologic Reviews*, 22(1): 136-139.

Glass, Thomas A., & McAtee, Matthew J. 2006. Behavioral science at the crossroads in public health: Extending horizons, envisioning the future. *Social Science & Medicine*, 62: 1650-1671.

Greco D.B., Simão M. 2007. Brazilian policy of universal access to AIDS treatment: sustainability challenges and perspectives. AIDS 21 (suppl. 4):S37 – S45.

GTPI – Group on Intellectual Property of the Brazilian Network for the Integration of Peoples (Rebrip). 2006. Why Brazil pays more for important medicines to public health? ABIA. Rio de Janeiro.

Gillespie, S. ed. 2006. AIDS, poverty, and hunger: Challenges and responses. Highlights of the International Conference on HIV/AIDS and Food and Nutrition Security, Durban, South Africa, April 14-16, 2005. Washington DC: International Food Policy Research Institute. Article used: Bond, V. 'Stigma when there is no other option: Understanding how poverty fuels discrimination toward people living with HIV in Zambia' (pp 181-197).

Gisselquist, D., Potterat, J., Brody, S., & Vachon, F. 2003. Let it be sexual: How health care transmission of AIDS in Africa was ignored. *International Journal of STD and AIDS*, 14(3): 148-161.

Goffmann, E. 1963. Stigma: Notes on the management of a spoiled identity. New York: Simon and Schuster.

Golub, J. E., Saraceni, V., Cavalcante, S. C., Pacheco, A. G., Moulton, L. H., King, B. S., Efron, A., et al. 2007. The impact of antiretroviral therapy and isoniazid preventive therapy on tuberculosis incidence in HIV-infected patients in Rio de Janeiro, Brazil. *AIDS*, 21(11), 1441-1448. doi:10.1097/QAD.0b013e328216f441

Goovaerts, P. & Jacquez, G. 2004. Accounting for regional bakgorund and population size in the detection of spatial clusters and outliers using geostatistical filtering and spatial neutral models: the case of lung cancer in Long Island, New York. *International Journal of Health Geographics*, 3(1): 14.

Granovetter, M. 1983. The Strength of Weak Ties: A Network Theory Revisited. *Sociological Theory*, 1: 201-233.

Gray-Felder, *Communication and Social Change: A Position Paper and Conference Report*

Greco, D.B., Simão, M. 2007. Brazilian policy of universal access to AIDS treatment: sustainability challenges and perspectives. *AIDS*, 21 (suppl. 4):S37-S45.

Guimarães, Y, Fortaleza registrou, em 2006, 13% menos casos de Aids em comparação a 2005, O Povo Newspaper-CE, 2007; 1st of Dec.

Gunneberg, Christian M.O. STB, World Health Organization, Geneva"TB/HIV Monitoring and Evaluation".

Hacker, M.A., Leite, I., Freidman, S.R. Carrijo, R.G., Bastos, F.I. 2009. Poverty, bridging between injecting drug users and the general population, and "interiorization" may explain the spread of HIV in southern Brazil. *Health & Place*, 15: 514-519.

Hazavehei, S.M., Taghdisi, M.H., & Saidi, M. 2007. Application of the Health Belief Model for Osteoporosis Prevention among Middle School Girl Students, Garmsar, Iran. Education for Health 7 (online), 23. Available from: http://www.educationforhealth.net

Herek, G.M. 2003. Thinking about AIDS and stigma: A psychologist's perspective. *Journal of Law, Medicine & Ethics* 30:594.

Holt, J.B. 2007. The Topography of Poverty in the United States: A Spatial Analysis Using County-Level Data From the Community Health Status Indicators Project. *Preventing Chronic Disease: Public Health Research, Practice, and Policy*, 4(4)

Huebner, D., Davis, M., Nemeroff, C., Aiken, L. 2002. The Impact of Internalized Homophobia on HIV Preventive Interventions. *American Journal of Community Psychology*, 30(3).

IBGE – Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics), Estimativas das Populações Residentes, em 1º de Julho de 2009, Segundo os Municípios (Estimated Population Report by Municipality); 07/2009.

– Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics), Censo Demográfico 2000: Agregado por Setores Censitários dos Resultados do Universo (Demographic Census 2000: Aggregates per Census Block). 2nd Edition, 2003. Rio de Janeiro, Brazil.

ICCHRLA – Inter-Church Committee on Human Rights in Latin America. 1996. *La violencia al descubierto: repression contra lesbianas y homosexuales en América Latina.*

ICRW – The International Center for Research on Women (2005), 'HIV-related stigma across contexts: common at its core' *Accessed May 16, 2010.*

Jamal, L. F., & Moherdaui, F. 2007. Tuberculose e infecção pelo HIV no Brasil: magnitude do problema e estratégias para o controle. *Revista de Saúde Pública*, 41. doi:10.1590/S0034-89102007000800014

Janz, N. K., Becker, M. H. 1984. The Health Belief Model: a decade later. *Health Education Quarterly*, 11; 1: 1-47.

Janzen, I., & Fishbein, M. 1980. Understanding Attitudes and Predicting Social Behavior. Englewood Cliffs, New Jersey: Prentice-Hall.

Kalipeni, Ezekiel & Zulu, Leo C. 2010. HIV and AIDS in Africa: a geographic analysis at multiple spatial scales. *GeoJournal - Spatially Integrated Social Sciences and Humanities*, 10;1007/s10708-010-9358-6.

Kamel Boulos, M.N., Roudsari, A.V. & Carson, E.R. 2001. Health Geometrics: An Enabling Suite of Technologies in Health and Healthcare. *Journal of Biomedical Informatics*, 34(3): 195-219.

Kearns, Robin A. 1993. Place and Health: Towards a Reformed Medical Geography. *Professional Geographer*, 45(2): 139-147.

Kistemann, T., Dangendorf, F., & Schweikart, J. 2002. New perspectives on the use of Geographical Information Systems (GIS) in environmental health sciences. *International Journal of Hygiene and Environmental Health*, 205(3): 169-181.

Koch, Tom. 2005. *Cartographies of Disease: Maps, Mapping, and Medicine.* Redlands, CA: ESRI Press.

Lang, Laura. 2002. *GIS for Health Organizations.* Redlands, CA: ESRI Press.

Levi, GC; Vitória, MAA. 2002. Fighting against AIDS: the Brazilian experience, *AIDS*, 16: 2373-2383.

Logan, J.R., Zhang, W., & Xu, H. 2010. Applying spatial thinking in social science research. *GeoJournal*, 75: 15-27.

Lorent, V., Thomas, I., Deliège, D., Tonglet, R. 2001. Deprivation and mortality: the implications of spatial autocorrelation for health resources allocation. *Social Science & Medicine*, 53; 12: 1711-1719.

Meade, Melinda S. & Earickson, Robert J. 2000. *Medical Geography*, 2nd ed., Gilford Press.

McLeroy, K.R., Bibeau, D., Steckler, A., Glanz, K. 1988. An ecological perspective on health promotion programs. *Health Education Quaterly*, 15; 4: 351-377.

Ministry of Health of Brazil, National STD/ AIDS Programme. 2002. *Positive Response: The Experience of Brazilian AIDS Program.* Brasilia: Ministry of Health. 64.

Mitchell, A. 2005. *The ESRI Guide to GIS Analysis: Volume 2: Spatial Measurements and Statistics*. Redland, CA: ESRI Press.

Moise, I.K. & Kalipeni, E. 2010. Applications of geospatial analysis to surveillance data: a spatial examination of HIV/AIDS prevalence in Zambia. *GeoJournal*, 1-16. doi: 10.1007/s10708-010-9349-7.

Montenegro, A.C.D., Werneck, G.L., Kerr-Pontes, L.R.S., Barreto, M.L. & Feldmeier, H. 2004. Spatial Analysis of the Distribution of Leprosy in the State of Ceará, Northeast Brazil. *Mem Ins Oswaldo Cruz*, 99(7): 683-686.

Moran, P.A.P., 1948. The interpretation of statistical maps. *Journal of the Royal Statistical Society*, series B:246-251

Mott, L. 2005. La homofobia, antes y ahora.

MSH – Management Sciences for Health: Management & Leadership Program, 2002. http://www.msh.org/projects/mandl/4.3.html *Accessed: May 12, 2010.*

Nemes, M.I.B., Carvalho, H.B., Souza, M.F.M. 2004. Antiretroviral therapy adherence in Brazil. *AIDS*, 18 (suppl. 3):S15-S20.

NHCHC – National Health Care for the Homeless Council, Inc. Last http://www.nhchc.org/humanright.html Updated: May 14th, 2010. *Accessed Ma16, 2010.*

Noar, S.M. 2006. A 10-year retrospective of research in health mass media campaigns: where do we go from here? *Journal of Health Communications*, 11(1): 21-42.

Nunn, A.S., Fonseca, E.M., Bastos, F.I., Gruskin, S. 2009. AIDS Treatment in Brazil: Impacts and Challenges, *Health Affairs*, 28(4): 1103-1113.

O'Donnel, M.M. et al. 2002. Poor response to tuberculosis treatment with regimens without rifampicin in immunosuppressed AIDS patients. *Braz J Infect Dis* [online], 6(6): [cited 2010-05-06], pp. 272-275 .

Oliveau, S., Guilmoto, C.Z. 2005. *Spatial correlation and demography: Exploring India's demographic patterns*, Paper presented at the International Population Conference, Tours, France.

Oliveira M.A., Esher A. 2004. Universal access to treatment for people living with HIV and AIDS in Brazil. In: Bermudez JAZ, Oliveira M.A., Esher A., editors. Acceso a medicamentos: derecho fundamental, papel del estado. Rio de Janeiro: ENSP: 233 – 250.

Osei, F.B., Duker, A.A. 2008. Spatial and demographic patterns of Cholera in Ashanti region – Ghana. *International Journal of Health Geographics*, 7:44-54

O'Sullivan, D. & Unwin, D. 2010. Geographic Information Analysis. Second Edition. John Wiley & Sons, Inc., Hoboken, New Jersey.

PAHO – Pan American Health Organization. 2008. Campaigns against Homophobia in Argentina, Brazil, Colombia, and Mexico. Washington D.C.: PAHO.

Paiva, V., Ayres, JR., Buchalla, C., Hearst, N. 2002. Building partnerships to respond to HIV/AIDS: non-governmental organizations and universities, *AIDS*, 16(suppl. 3):S76-S82.

Parker, RG. 2009. Civil Society, Political Mobilization, and the Impact of HIV Scale-Up on Health Systems in Brazil, *Journal Acquired Immune Deficiency Syndrome (JAIDS)*, 52(suppl. 1):S49-S51.

Parker, R. 2002. The Global HIV/AIDS Pandemic, Structural Inequalities, and the Politics of International Health. *American Journal of Public Health*, 93(3): 343-346.

Parker, R. & Aggleton, P. 2003. HIV and AIDS-related stigma and discrimination: a conceptual framework and implications for action. *Social Science & Medicine* 57, no. 1 (July): 13-24. doi:10.1016/S0277-9536(02)00304-0.

Parker, R., Attawel, K., Pulerwitz, J., and Brown, L. 2002. HIV/AIDS related stigma and discrimination: a conceptual framework and an agenda for action. Washington DC: Horizons Program & Population Council.

Parkhurst, J.O., Lush, L. 2004. Political environment of HIV: lessons from a comparison of Uganda and South Africa, *Social Science & Medicine*, 59: 1913-1924.

Peng, Z-H., Cheng, Y-I., Reilly, K.H., Wang, L., Qin, Q-Q., Ding, Z-W., Ding, G-W., Ding, K-Q., Yu, R-B., Chen, F., & Wang, N. 2011. Spatial Distribution of HIV/AIDS in Yunnan province, People's Republic of China. *Geospatial Health*, 5(2): 177-182.

Pedral-Sampaio, D. B., Alves, C. R., Netto, E. M., Brites, C., Oliveira, A. S., & Badaro, R. 2004. Efficacy and safety of Efavirenz in HIV patients on Rifampin for tuberculosis. *Brazilian Journal of Infectious Diseases*, 8, 211-216.

Peters. D.H., Garg, A., Bloom, G. Walker, D.G., Brieger, W.R., Rahman M.H. 2008. Poverty and Access to Health Care in Developing Countries. *Annals of the New York Academic of Sciences*, 1136: 161-171.

Portela, M.C., Lotrowska, M. 2006. Health care to HIV/AIDS patients in Brazil, *Revista de Saúde Pública*, 40(suppl.):1-9.

Potts, A. 2003. *Socio-economic status and HIV/AIDS in sub-Saharan Africa. Behavioral science and health.* University of Utah Press.

Prefeitura de Fortaleza (Fortaleza City Hall) Website. http://www.fortaleza.ce.gov.br *Accessed April 4, 2010.*

Ramos, R., Ferreira-Pinto, J.B., Brouwer, K.C., Ramos, M.E., Lozada, R.M., Firestone-Cruz, M., Strathdee, S.A. 2009. A tale of two cities: Social and environmental influences shaping risk factors and protective behaviors in two Mexico-US border cities. *Health & Place*, 15: 999-1005.

Ray, N. & Ebener, S. 2008. AccessMod 3.0: computing geographic coverage and accessibility to health care services using anisotropic movement of patients. *International Journal of Health Geographics*, **7**:63doi: 10.1186/1476-072X-7-63.

- ACCESSMOD3. Physical Accessibility to Health Care and Population coverage Modeling User Manual. WHO, Geneva 2008.

Rhodes, Tim. 2002. The 'risk environment': a framework for understanding and reducing drug-related harm. *International Journal of Drug Policy*, 13(2): 85-94.

Rhodes, T. & Simic, M. 2005. Transition and HIV risk environment. *BMJ (British Medical Journal)*, 331: 220-223.

Rhodes, T., Singer, M., Bourgois, P., Friedman, S.R., Strathdee, S.A. 2005. The social structural production of HIV risk among injecting drug users. *Social Science Medicine*, 61(5): 1026-1044.

Rhodes, T., Stimson, G.V., Crofts, N., Ball, A., Dehne, K., Khodakevich, L. 1999. Drug injecting, rapid HIV spread, and the 'risk environment': implications for assessment and response. *AIDS*, 16(suppl. 3): S34-41.

Romer, D., Sznitman, S., DiClemente R., Salazar, L.F., Vanable P.A., Carey, M.P., Hennessy, M., Brown, L.K., Valois, R.F., Stanton, B.F., Fortune, T., & Juzang, I. 2009. Mass media as an HIV-prevention strategy: using culturally sensitive messages to reduce HIV-associated sexual behavior of at-risk African American youth. *American Journal of Public Health*, 99(12): 2150-2159.

Rosenstock, I.M., Strecher, V.J., Becker, M.H. 1994. The Health Belief Model and HIV Risk Behavior Change. In *Preventing AIDS: Theories and Methods of Behavioral Interventions*, eds. DiClemente, Ralph J., Peterson, John L. 05-24. New York, New York: Plenum Press.

Rosenstock, I.M. 1966. Why people use health services. *Milbank Memorial Fund Quarterly*, 44(suppl. 4): S127.

Sayce, L. 2003. Beyond good intentions: making anti-discrimination strategies work. *Disability and Society* 18: 625-642.

Scambler, G. 2004. Re-framing stigma: Felt and enacted stigma and challenges to the sociology of chronic and disabling conditions. *Social Theory & Health* 2/1:29-46.

Scribner, Richard; Theall, Katherine P.; Simonsen, Neal; and Robinson, William. 2010. HIV Risk and the Alcohol Environment - Advancing an Ecological Epidemiology for HIV/AIDS. *Alcohol Research and Health NIH Publications (NIAAA)*, 33(3): 179-183. http://www.alcoholhivconference2010.org/downloads/pdf/Alcohol-Research-and-Health-NIH-publication_vol-33,No.1&2_2010.pdf

Seal, D., Kelly, J., Bloom, F., Stevenson, L., Coley, B., Broyles, L. 2002. HIV prevention with young men who have sex with men: what young men themselves say is needed. *AIDS Care*, 12(1).

SES – SP : Secretaria de Estado da Saúde de São Paulo. Coordenadoria de Controle de Doenças. Centro de Referência e Treinamento DST/aids. Tuberculose e HIV/aids. Boletim Epidemiológico CRT-DST/aids. São Paulo (SP). 2005; ano IV, n. 1; 6-7.

Shannon, Gary W., Reviews the book 'The Slow Plague: A Geography of the AIDS Pandemic' by Peter Gould. *Annals of the Association of American Geographers*, 84(4): 760-762.

Shenoi SV, Escombe AR, Friedland G. 2010. Transmission of drug-susceptible and drug-resistant tuberculosis and the critical importance of airborne infection control in the era of HIV infection and highly active antiretroviral therapy rollouts. Clin Infect Dis., May 15; 50(Suppl 3):S231-7

Stokols, D.1996. Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion*, 10; 4: 282-298.

SUS – http://www.brasil.gov.br/para/worker/health/what-is-sus-1/br_model1?set_language=en. Accessed: Dec. 15, 2010.

Szwarczwald C.L., Carvalho M.F. 2000. Estimated numbers of HIV-infected individuals aged 15-49 years in Brazil, 1998. Cad Saúde Publica.16(suppl 1):135 – 141.

Teixeira, P.R., Vitória, M.A., Barcarolo, J. 2004. Antiretroviral treatment in resource-poor settings: the Brazilian experience. *AIDS*, 18(suppl. 3):S5-S7.

Teixeira, P.R., Vitória, M.A., Barcarolo, J. 2003. The Brazilian Experience in Providing Universal Access to Antiretroviral Therapy. *Economics of AIDS and Access to HIV/AIDS Care in Developing Countries: Issues and Challenges*, 69-88. http://www.lepublieur.com/anrs/ecoaids6.pdf *Accessed July 17, 2011*.

Terry, Deborah J, Gallois, Cynthia, and McCamish, Malcolm. 1993. The Theory of Reasoned Action and Health Care Behaviour. In *The Theory of Reasoned Action - Its Application to AIDS-Preventive Behaviour*, eds. Terry, Deborah J, Gallois, Cynthia, and McCamish, Malcolm. 01-28. Oxford, England: Pergamon Press.

Tobler, W.R. 1970. A computer movie simulating urban growth in the Detroit region. *Economic Geography*, 46: 234-240.

UNAIDS. 2008. Report on the Global AIDS Epidemic. http://www.unaids.org/en/KnowledgeCentre/HIVData/GlobalReport/2008/ *Accessed May 10, 2010.*

UNDP – United Nations Development Programme, Human Development Report 2009 – Human Development Index (HDI) Rankings, http://hdr.undp.org/en/statistics/ *Accessed March 28, 2010.*

USAID Infectious Diseases Website http://www.usaid.gov/our_work/global_health/id/tuberculosis/countries/lac/brazil_profile.html *Accessed May 6th, 2010.*

Waller, L.A. & Gotway, C.A. 2004. *Applied Spatial Statistics for Public Health Data.* John Wiley & Sons, Inc.

Waller, L.A. & Jacquez, G. 1995. Disease models implicit in statistical tests of disease clustering. *Epidemiology*, 6: 584-590.

Walter, S.D. 1992. The analysis of regional patterns in health data. II The power to detect environmental effects. *American Journal of Epidemiology*, 136: 742-759.

Wilson, J. & Fotheringham, A.S. 2007. *The Handbook of Geographic Information Science*. Blackwell Publishing.

WHO – World Health Organization, Addressing Poverty in TB Control: Options for National TB Control Programmes. WHO/HTM/TB/2005.352 http://whqlibdoc.who.int/hq/2005/WHO_HTM_TB_2005.352.pdf *Accessed May 6th, 2010.*

WHO & UNAIDS. 2006. *Progress on global access to HIV antiretroviral therapy: A report on '3 by 5' and beyond.*

Williamson, I.R. 2000. Internalized homophobia and health issues affecting lesbians and gay men. *Health Education Research,* 15(1): 97-107.

Wilson, J. & Fotheringham, A.S. 2007. *The Handbook of Geographic Information Science*. Blackwell Publishing.

Wood, R. 2009 (February 3). HIV/TB: When is it safe to start HAART? Southern African Journal of HIV Medicine Association of Crop Science, Uganda. Retrieved from http://www.ajol.info/viewarticle.php?id=45671

Yeboah, I.E.A. 2007. HIV/AIDS and the construction of Sub-Saharan Africa: Jeuristic lessons from the social sciences for policy. *Social Science and Medicine,* 64(5): 1128-1151.

Zenk, S.N., Schulz, A.J., Israel, B.A., James, S.A., Bao, S., Wilson, M.L. 2005. Neighborhood Racial Composition, Neighborhood Poverty, and the Spatial

Accessibility of Supermarkets in Metropolitan Detroit. *American Journal of Public Health*, 95(4):660-667

Data sources

CEVEPI (Célula de Vigilancia Epidemiologica de Fortaleza) – Center for Epidemiological Vigilance in Fortaleza. http://www.sms.fortaleza.ce.gov.br/sms_v2/vigiliancias_EpidemiologicaSINASCSIM.asp

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